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THE UNIVERSITY OF KANSAS

SCIENCE BULLETIN

VOL. XXXIII, PT. I] APRIL 20, 1949 [NO. 1

A Monograph of the Genus *Taphrina*

A. J. MIX

ABSTRACT: The genus *Taphrina,* founded by Fries in 1832 on the species *Taphrina populina,* is the only recognized genus in the family Taphrinaceae, order Taphrinales of the Ascomycetes.

All species of the genus are parasitic on higher plants or ferns, forming mycelium (*a*) intercellularly; (*b*) subcuticularly; or (*c*) within the epidermal wall; forming asci in a subcuticular layer or in a wall locule; overwintering in the form of blastospores derived from ascospores by budding or in a few species as perennial mycelium. Infection (so far as known) is by blastospores.

Asci arise from rounded ascogenous cells (chlamydospores), either by elongation of the ascogenous cell or by bursting out from the ascogenous-cell wall. In many species a stalk cell (basal cell) is cut off from the ascus proper. Budding of the ascospores to form blastospores may occur within the ascus and continues after spore expulsion.

Mycelium is dicaryotic. Fusion of nuclei occurs in the ascogenous cell; meiosis in the young ascus. In one species (*T. epiphylla*) conjugation of ascospores (or blastospores) occurs, resulting in dicaryotic hyphae. In other species (so far as known) the dicaryotic condition is attained by division of the single nucleus of the blastospore.

Species of *Taphrina* grow readily in artificial media if cultures are originated from ascospores or blastospores; behaving in media as yeasts. Cells formed in culture are blastospores, hyphae, ascogenous cells, and (rarely) asci.

Ninety-eight species of *Taphrina* are here redescribed and redefined (other species being reduced to synonymy or excluded). These are distributed by hosts as follows: On Ferns, 24 species; on *Populus* and *Salix,* 4; on *Betulaceae,* 23; on *Fagaceae,* 5; on *Ulmaceae,* 2; on *Rosaceae* (except *Prunus*), 7; on *Prunus,* 17; on *Rhus,* 1; on *Acer,* 11; on *Aesculus,* 1; on *Sebastiana,* 1; on *Zingiberaceae,* 2.

INTRODUCTION

IN earlier papers on the genus *Taphrina* an account of important literature (Mix, 1936) and a list of presumably valid species (Mix, 1936a) was presented. Since this species-list was compiled from the literature and was not based on the study of actual specimens, its value could be only temporary.

Following publication of these papers, morphological studies[1] have been completed of all known species of *Taphrina,* and it is now possible to undertake a thorough revision of the genus.

In certain cases the results of inoculation-experiments would be helpful in reaching decisions on the identity of species, but for the most part delimitation of species can be made on morphological grounds. Interesting as biologic relationships will prove, their elucidation is not likely to result in either combination or division of morphologically evident species. Therefore, although many species of *Taphrina* have been obtained in culture, and host relationships are being studied by means of inoculations, it seems unnecessary to await the results of these studies before proceeding to a revision of the genus.

The present paper gives an account of all known species of *Taphrina.* It is proposed to treat these species by host groups, discussing first species occurring on ferns and then those on Dicotyledons and Monocotyledons, following the taxonomic arrangement of host genera. For nomenclature of woody plants Rehder's Manual of Cultivated Trees and Shrubs has been consulted. Other higher plants have been named in agreement with Index Kewensis and ferns in accordance with the usage of the Gray Herbarium.

In this revision an effort has been made to disturb existing situations as little as possible, especially as regards division of species and erection of new species therefrom. In some cases description of new species has seemed unavoidable, and, on the other hand, it has sometimes seemed necessary to combine two or more existing

1. These studies were made, for the most part, during the period 1935-1940. They were aided by mycologists the world over who sent valuable specimens as loans or gifts. Space will not permit naming all of these collaborators but grateful acknowledgment to them is hereby made.

Thanks are due also to the Chancellor and Board of Regents of the University of Kansas for leave granted in 1939-1940, to Dr. Carl Hammarlund for laboratory facilities at Statens Växtskyddanstalt, Stockholm; to Dr. Th. Arwiddson for working privileges at the Botaniske Riksmuseum, Stockholm; and to Dr. L. M. Massey for a temporary appointment in the Department of Plant Pathology, Cornell University, during the winter, spring, and summer of 1940.

The late Dr. D. H. Linder was so kind as to make available the facilities of the Farlow Herbarium during the autumn of 1939.

species into one. Many species of *Taphrina* have in the past been described as new without due regard to existing species. In some cases occurrence on a new host was considered sufficient reason for erecting a new species. In other cases morphological peculiarities described by the author of a species have been found to disappear when a number of specimens are examined. Finally, in a few instances, species were hastily and inaccurately described.

In determining the validity of species the principle followed has been to treat as identical those forms that are morphologically similar and occur on related hosts. This is considered sound procedure even when biological distinction is known to exist between different host-forms. The well known treatment accorded the rust fungi by workers within that group may be cited in defense of this point of view.

In critical cases type specimens have been examined. This has not been thought necessary in the case of old and well established species, much studied by earlier authors, such as *Taphrina populina, T. deformans, T. pruni.* Whenever possible study of the type specimen has been supplemented by examination of a number of additional specimens, which has invariably resulted in widening the limits of ascus-size given by the original authors. Often a similar correction has resulted from the study of the type specimen itself.

The species descriptions, then, presented in this paper are in most cases revisions of the descriptions given by the original authors, and, being based on the study of as many specimens as possible, may be accepted as accurate descriptions of the fungi concerned insofar as they are known.

Morphological features considered in delimiting species are those used by all previous investigators: habit of mycelium (whether intercellular, subcuticular, or growing within the host-cell wall), shape and size of asci, presence or absence of a stalk cell, shape and size of stalk cells, and (rarely) size of spores.

CHARACTER OF THE GENUS AND RELATIONSHIPS

The order *Taphrinales* (*Exoascales*) of the Ascomycetes is commonly held to contain but one family, the *Taphrinacae (Exoascacae)* Gaümann (1926) includes a second family, the *Protomycetaceae,* with two genera: *Protomyces* and *Taphridium.* All members of the *Protomycetaceae* are parasitic, causing galls within the tissues of higher plants.

Species of *Protomyces* form in the tissues of their hosts large, round, thick-walled, overwintering chlamydospores. Such a chlamy-

dospore germinates in the spring, its outer wall rupturing and the inner thin-walled cell emerging as a sporangium (ascus or synascus). In the peripheral cytoplasm of the sporangium numerous nuclei divide by meiosis (Büren, 1915), each producing a tetrad of spore mother cells, which by further division form the spores. Spores, after expulsion, conjugate in pairs.

The genus *Taphridium* differs from *Protomyces* in that the chlamydospores are formed in a continuous layer beneath the host epidermis. All known species of *Taphridium* were originally described as species of *Taphrina* (*Magnusiella*).

In the family *Taphrinacae* one valid genus (*Taphrina*)[2] is known. The type species is *Taphrina populina* Fries. Fries first (1815) called this fungus *Taphria populina aurea* and subsequently (1825) changed the genus name to *Taphrina,* stating that *Taphria* had been used as an insect name. In *Systema Mycologicum* (1832), Fries used the name *Taphrina populina* for this fungus.

All known species of *Taphrina* are parasitic, though susceptible (so far as investigated) of artificial cultivation in the asexual stage (Klebahn, 1923, Mix, 1924, Wieben, 1927)[3]. Cultures may be initiated by ascospores[4] or by blastospores derived from them. Slow growing, yeast-like, pale pink colonies are formed on various media and cultures can apparently be propagated indefinitely. Cells formed in culture are chiefly blastospores (yeast cells or bud-conidia), though occasionally short hyphae may be observed, and thick walled "resting cells" are common. These "resting cells" are believed by the writer (Mix, 1924, 1935) to be ascogenous cells like those formed beneath the cuticle of the host. Martin (1940), not finding binucleate "resting cells" in her cultures, believed them to be vegetative cells. In old cultures dicaryotic hyphae (like those in host tissues) may occur, as well as ascogenous cells with fusing nuclei, and even imperfectly formed asci. (Mix, 1935.) Roberts

2. Other genera have been recognized: *Ascomyces, Exoascus, Magnusiella,* but since the papers by Johanson (1886) and Giesenhagen (1895, 1901) the common practice has been to unite these all into one genus, for which the name *Taphrina* has priority. A full account of the use of these different generic names by various authors has been given earlier (Mix, 1936).

3. Following the discovery by Klebahn (1923) and by the writer (1924) that species of *Taphrina* could be grown in pure culture, Martin (1925) published notes on cultural behavior of several species. Examination of her cultures, made shortly afterwards, showed that three of them were wrongly named. One, called by Martin *Taphrina communis* has proved to be a species of *Torulopsis.* Her culture from *Quercus nigra,* called *Taphrina caerulescens,* is a species of *Rhodotorula,* and another isolate so named but from *Q. rubra* is a second and different species of *Rhodotorula.* Apparently the rest of Martin's cultures were authentic.

4. The writer's procedure in obtaining pure cultures is to place ascus-bearing leaf-fragments in the cover of an inverted petri dish of potato glucose (or other) agar. Ascospores are shot upward onto the agar, the spores of each ascus coming to lie together in a symmetrical group. If the process is not allowed to continue too long the groups of spores are spaced well apart and resultant colonies can be observed microscopically until it is convenient to transfer them.

(1946) considers that ascogenous cells and asci may be formed in culture, but was unable to find any binucleate cells.

In nature the ascospores bud readily, either within the ascus or after spore expulsion. There is reason to believe (Fitzpatrick, 1934, Mix, 1935) that propagation by budding in this "yeast stage" may continue indefinitely, the fungi surviving in this fashion on various plant surfaces and probably also in the soil. In other words species of *Taphrina* are yeasts (in the broad sense) during their asexual cycle. In fact if a species of *Taphrina* were brought into culture without knowledge of its previous parasitic existence, it would be called a species of *Torulopsis.*

In some cases, as in *Taphrina epiphylla,* infection apparently occurs soon after ascospore expulsion, but in other cases (presumably because host organs are susceptible only when young and tender), a period of oversummering and overwintering is undergone by the blastospores before infection. The occurrence of the "yeast stage" seems to be important in accomplishing survival during this prolonged period apart from the host tissues. For example, it is evident (Fitzpatrick, 1934, Mix, 1935) that *Taphrina deformans* can survive as a yeast for more than one year.

Infection by blastospores has been observed by Fitzpatrick (1934) and Mix (1935) in *Taphrina deformans.* Successful inoculation experiments were performed by Sadebeck (1882) with *Taphrina bullata* and *T. tosquinetii* and later (1888, 1890) with *T. epiphylla.* Fisch (1885) also reports successful inoculations with *T. tosquinetii* and *T. epiphylla.* Klebahn (1923), inoculating from pure culture, obtained infection with *Taphrina tosquinetii* on *Alnus glutinosa,* but failed in attempts with *T. epiphylla, T. sadebecki,* and *T. betulina* on their respective hosts. Wieben (1927) also used pure cultures in her inoculation-experiments, securing positive results with *Taphrina tosquinetii, T. epiphylla, T. deformans;* negative with *T. populina* (*T. aurea*), *T. bullata,* and *T. klebahni.*

Species of *Taphrina* are of three types as regards mycelial habit: intercellular forms (*Taphrina deformans,* etc.) developing abundant mycelium between the interior cells of leaf, stem, or fruit, and subsequently forming a subcuticular layer of ascogenous cells; subcuticular forms (*Taphrina epiphylla,* etc.) whose mycelium and ascogenous cells grow only beneath the cuticle; and wall-inhabiting forms (*Taphrina laurencia,* etc.), living entirely within the outer epidermal wall of the host. In *Taphrina maculans* (Butler,

1911) and *T. linearis* (Mix, 1939) this "wall-habit" is developed further. Flat bands of hyphae occur within radial walls between adjacent cells of the epidermis and of the underlying tissues. None of the intercellular or subcuticular forms is known to possess haustoria but specialized haustoria have been reported (Butler, 1911) for *T. maculans,* and unspecialized haustoria for *T. laurencia* (Giesenhagen, 1892), *T. osmundae* and *T. higginsii* (Mix, 1947). Most wall-inhabiting forms produce numerous ascogenous cells within a wall locule (Mix, 1939) but in the two species just named a single multinucleate hyphal segment occurs in each wall locule and this later gives rise to a single ascus (Mix, 1947).

Intercellular mycelium of species of *Taphrina* is for the most part developed within the spaces between host cells, but in passage of an infection hypha inward through the epidermis, and (later on) of mycelium outward to form a subcuticular layer, growth occurs perforce within radial walls between epidermal cells. In discussing *Taphrina deformans,* Martin (1940) states: ". . . vertical hyphae are found between radial walls of epidermal cells and not in these walls as described by Mix." This is a contradiction in terms. With no radially-placed intercellular spaces between epidermal cells of the peach only one location is possible for the vertically-growing mycelium and this may be described either as "in the cell wall" or "between cell walls." The writer's expression was chosen since it is not known whether the mycelium of *Taphrina deformans* dissolves out the middle lamella or whether it may not also attack the cellulose membranes.

Several species of *Taphrina* have been investigated cytologically. There is general agreement (Dangeard, 1895, Ikeno, 1901, Juel, 1921, Martin, 1924, Eftimiu, 1927, Martin, 1940) that mycelium with the host tissues is dicaryotic, each cell containing one or more pairs of nuclei which divide conjugately. Nuclear fusion occurs in ascogenous cells, as reported by Dangeard (1895) for *T. deformans* and by Juel (1921), Eftimiu (1927), and Martin (1924, 1940), for this and other species. The ascogenous cell is termed a chlamydospore by Juel.

In germination of the chlamydospore (ascogenous cell) two types of behavior have been observed. Juel (1921) found that in *Taphrina epiphylla* and in *T. sadebeckii* a pore forms in the outer wall of the chlamydospore, and the ascus emerges as a thin walled endospore through this widening pore.

In other species: *Taphrina betulina, T. carnea,* Juel found that the chlamydospore itself elongates to form the ascus; its wall becomes thinner in the process but does not rupture.

Martin (1940) writing of *Taphrina deformans* says: "After the nuclear fusion, the ascogenous cell elongates vertically and its thick wall is stretched to become the thinner wall characteristic of the ascus. The wall of the ascogenous cell does not break for the ascus to emerge as described by Pierce (1900) and Juel (1921)." Juel did not discuss *Taphrina deformans* in the paper referred to but Pierce (1900) writes as follows: "As already said, the walls of the ascogenous cells are heavy. The early steps in the development of the asci from these cells (the development of a papilla-like elevation on the upper surface of the cells) cause the rupture or the dissolution of the heavy wall where the elevation occurs. The phenomenon is that of the germination of a heavy-walled spore, or perhaps, more properly, the outgrowth or prolongation of an endospore through the rupture of the epispore."

Whether the ascus of *Taphrina deformans* ever forms in this manner seems to be difficult to determine. In all preparations made by the writer the ascogenous cell elongates to an ascus, in the fashion described by Martin (l. c.). If Pierce's observations are correct they cannot hold true for the majority of asci.

On the other hand, this phenomenon of ascus emergence by rupture of the chlamydospore wall (as described by Pierce for *Taphrina deformans,* and by Juel for *T. epiphylla*) is readily seen in certain other species. It has been observed (as noted below) in *Taphrina tosquinetii, T. sadebeckii, T. amentorum, T. epiphylla, T. occidentalis, T. thomasii, T. acerina* and *T. acericola.*

Meiosis occurs in the young ascus (Juel, 1921, Eftimiu, 1927, Martin, 1924, 1940). Eftimiu (1927) reports the diploid number for several species as four, while Martin (1940) reports it for *Taphrina deformans* as eight. Juel and Eftimiu find meiosis occurring in the first division of the fusion nucleus, Juel stating that in species possessing stalk cells the protoplasm migrates into the upper portion of the ascus before nuclear division, and that later an empty stalk cell is cut off. Martin (1924, 1940) reports that in *T. coryli* and *T. deformans,* the first division of the diploid ascus nucleus is mitotic and that the stalk cell possesses for a brief period a diploid nucleus and cytoplasm. These observations of Martin will, if confirmed, be extremely important, since the occurrence of a diploid

thallus is rare among fungi, having been previously reported by Guilliermond and others for certain yeasts (Guilliermond, 1940), and by Guilliermond (1928) for *Spermopthora gossypii*. A close relation between the Taphrinales and the Saccharomycetales would be indicated.

Ascospores are uninucleate and haploid, as are the blastospores derived from them. The dicaryotic condition seems to be attained in most species (Eftimiu, 1927, and others) by nuclear division, a dicaryon thus being a pair of sister nuclei.

In *Taphrina epiphylla* (*T. klebahni* is, as will appear later, a synonym) Wieben (1927) reported conjugation between sexually different ascospores (or blastospores) and development of a dicaryotic hypha from the fusion-cell. (Presumably this is the infection thread but the point has not been determined.) Wieben's observations were confirmed by the writer (1935).

Conjugation has not been observed as occurring regularly in any other species, though it seems to occur rarely in *Taphrina deformans* (Mix, 1935). With this fungus, however, infection has been obtained by Fitzpatrick (1934) and the writer (1935) using cultures derived from single ascospores.

TAXONOMIC ACCOUNT

I. SPECIES ON FERNS

Most species of *Taphrina* inhabiting ferns possess slender clavate asci. Giesenhagen (1895), calling this the "Filicina-type" of ascus, made it the basis for dividing the genus into subgenera. In other respects, especially in mycelial habit (Mix, 1939) species on ferns are remarkably diverse. That the series on ferns exhibits a variety of development not equalled by the species on any other host group, may be one indication of the antiquity [5] of the genus.

1. *Taphrina athyrii* Siemaszko

Taphrina athyrii Siemaszko, Bull. Musée du Caucase 12:20-28. 1919.

Causing small (5 mm. or less in diameter), yellow to brown, unthickened spots on leaves of *Athyrium filix-femina* Roth and *Dryopteris spinulosa* (Muell.) Kuntze. The spots are margined by small veins, though they often occupy more than one vein-islet. At maturity of the asci both surfaces of the spot are covered with a whitish bloom except for a narrow unwhitened margin.

Mycelium subcuticular.

Asci amphigenous, broadly clavate to nearly oblong, rounded or truncate at the apex, provided with a stalk cell. Ascospores round, ovate, elliptic, or fusiform, frequently budding in the ascus. (Figure 1, A, B.)

Dimensions: of asci, 13-17μ×5.5-10μ of *stalk cells,* 4.5-8μ× 5-8μ; of *spores,* 2.5-6μ × 2-3.5μ.

Distribution: On *Athyrium filix-femina,* Norway. On *Dryopteris spinulosa,* Caucasus.

Material examined: A. filix-femina. Norway: Sogn and Fjordane, Hauglund, Brekke in Lavik, Aug. 12, 1927, T. Lillefosse (received from Ivar Jørstad).

D. spinulosa. Caucasus: Pschu, Sept. 17, 1917. (Part of Siemaszko's type collection. Two lots of this were studied, one obtained from Dr. A. E. Jenkins, one from Siemaszko.)

This fungus was described by Siemaszko as occurring on *Athyrium filix-femina,* but in a letter accompanying a portion of his type

5. The occurrence of fossilized *Taphrina amentorum* in interglacial deposits near Ejstrup, Denmark, is reported by Lind (1913).

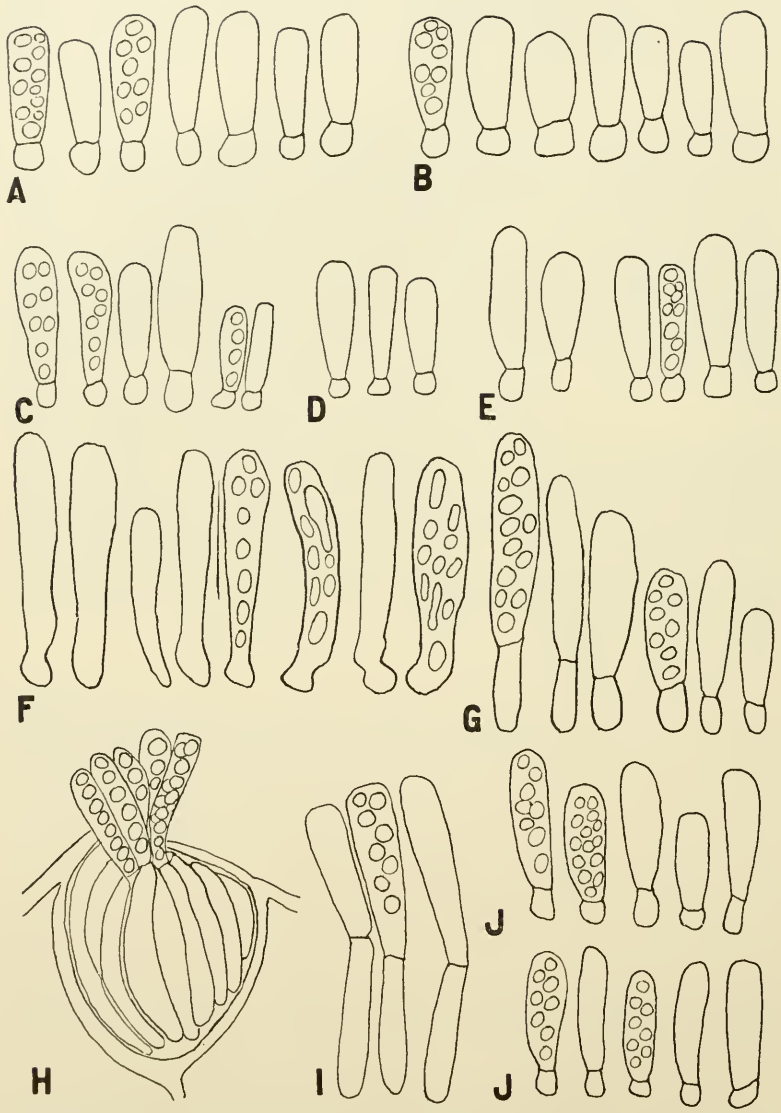

FIG. 1. Asci (×900) of, A, *Taphrina athyrii* on *Dryopteris spinulosa;* B, on *Athyrium filix-femina;* C, *T. hiratsukae* on *Onoclea sensibilis;* D, on *Pteretis nodulosa;* E, on *Pteretis struthiopteris;* F, *T. blechni;* G, *T. cystopteridis;* H, I, *T. californica;* J, *T. cornu-cervi.*

material he stated that he had been mistaken and that the host was *Dryopteris spinulosa*. The species name is saved from being a misnomer by the Norwegian material. *Taphrina athyrii* is very close to *T. hiratsukae* in all respects, but may be distinguished by the consistently broader ascus and by the nearly isodiametric stalk cell.

2. *Taphrina hiratsukae* Nishida

Taphrina hiratsukae Nishida, Miyabe Festschrift, Tokyo, 1911.
T. struthiopteridis Nishida, l. c.
T. struthiopteridis Siemaszko, Bull. Musée du Caucase, **12**:20-28. 1919.
T. siemaszkoi (Siem.) Mix, Univ. Kansas Sci. Bull. **24**:150-176. 1936.

Causing small (up to 5 mm. in diameter), yellow (becoming brown with age), unthickened spots on leaves of *Onoclea sensibilis* L., *Pteretis nodulosa* (Michx.) Nieuwl., *Pteretis struthiopteris* (L). Todaro, and *Thelypteris thelypteris* (L.) Nieuwl. The spots may be margined by the small veins of the leaf, though occupying more than one vein-islet. At maturity of the asci the lower surface of the spot becomes covered with a whitish bloom except for the narrow unwhitened margin.

Mycelium subcuticular.

Asci hypophyllous, clavate, rounded or truncate at the apex, provided with a stalk cell. Ascospores ovate or elliptic, frequently budding in the ascus. (Fig. 1, C, D, E.)

Dimensions: Of *asci,* 13-30μ × 4-18μ; of *stalk cells,* 4-10μ × 3-5μ; of *spores,* 2-6μ × 2-4μ.

Distribution: On *Onoclea sensibilis,* New York, Ontario, Pennsylvania, Japan. On *Pteretis nodulosa,* Manitoba, Wisconsin. On *Pteretis struthiopteris,* Caucasus. On *Thelypteris thelypteris,* Japan.

Material examined: Onoclea sensibilis. New York: Hudson Falls, Aug. 7, 1919, J. Dearness. Pennsylvania: Houserville, Aug. 10, 1921, C. R. Orton and W. A. McCubbin. Ontario: swamp east of Wilcox Lake, Aug. 4, 1930, H. S. Jackson. Japan: Pref. Iwate, Morioka, July 22, 1934, K. Togashi.

Pteretis nodulosa. Wisconsin: Weyerhaeuser, J. J. Davis.

Pteretis struthiopteris. Caucasus: Pschu, Sept. 13, 1917, W. Siemaszko (duplicate of Siemaszko's type material of *T. struthiopteridis*).

Thelypteris thelypteris. Japan: Pref. Iwate, Mt. Iwate, Aug. 17, 1903, G. Yamada.

In the species list previously published (Mix, 1936a), *Taphrina struthiopteridis* Siemaszko was, on the basis of Siemaszko's descrip-

tion, held to be distinct from *T. struthiopteridis* Nishida, and the fungus was therefore renamed *Taphrina siemaszkoi.* Siemaszko described this fungus as having asci 28-40μ × 6-7μ and did not mention a stalk cell, while Nishida's fungus was described as having asci 16-28μ × 4-6μ with stalk cells 4-7μ × 3-4μ. In a letter accompanying his type material Siemaszko stated that his measurements had been wrong, giving the following as correct: Asci 17.5-32μ × 6-7.5μ, again not mentioning the stalk cell. He said further that his fungus was probably identical with *T. struthiopteridis* Nishida. Study of the material obtained from Siemaszko, and of duplicate material in the Farlow Herbarium showed asci 17-28μ × 5-7μ, and stalk cells 4-7μ × 3-6μ.

It is not possible to distinguish from each other the fungi under discussion either on the basis of host lesions or of size and shape of asci and stalk cells. They are therefore held to be the same species.

Since Nishida described his two fungi in the same paper it becomes a question which name should receive priority. The name *Taphrina hiratsukae* Nishida is chosen since it would precede *T. struthiopteridis* in an alphabetical list of species. The close similarity of *Taphrina hiratsukae* to *T. athyrii* has been mentioned above. It is not impossible that these two species are identical.

3. *Taphrina blechni* (Bresadola) ex Mix.

Taphrina blechni Bresadola ex Mix, Trans. Kansas Acad. Sci. **50**:77-83. 1947.

Causing small, round or ellipsoid, unthickened spots on leaves of *Blechnum* sp.

Mycelium subcuticular.

Asci amphigenous, clavate, truncate at the apex, often with a curved foot, lacking a stalk cell. Ascospores ellipsoidal. Numerous elongate spores (apparently blastospores) may be present in the ascus. (Fig. 1, F.)

Dimensions: Of *asci,* 23-60μ × 4-7μ; of *ascospores,* 2-5μ × 2-4μ; of *blastospores,* 5-6.5μ × 0.5-1.5μ.

Distribution: Brazil.

Material examined: BRAZIL: Rio de Janeiro, Serra Geral, Oct. 1891, E. Ule (E. Ule, Herb. Brasil. 1786). Bot. Mus. Berlin, Bot. Mus. Stockholm.

Bresadola named (in the above mentioned Exsiccati) this fungus but did not publish a description. This has been supplied by the writer (Mix, 1947a).

4. *Taphrina cystopteridis* Mix

Taphrina cystopteridis Mix, Mycologia **30**:563-569. 1938.

Causing small (0.5 to 2.0 mm. in diameter) galls on leaves of *Cystopteris fragilis* (L.) Bernh.

Mycelium intercellular.

Asci epiphyllous or amphigenous, clavate, rounded or truncate at apex, provided with a stalk cell. Ascospores eight, round, ovate or elliptic.

Dimensions: Of *asci,* 20-30μ × 4-7.5μ, of *stalk cells,* 6-19μ × 4-6μ, of *spores,* 3-6 × 2-3.5μ. (Fig. 1, G.)

Distribution: Indiana, Kansas, Wisconsin.

Material examined: Indiana: Daviess County, Glendale, June 4, 1923, C. C. Deam; Greencastle, May 23, 1922, id. Kansas: Neodesha, June, 1936, W. H. Horr (type material); same locality, June, 1937, and June, 1938, A. J. M. Wisconsin: Brodhead, Sept. 16, 1926, J. J. Davis.

The earliest collection of this fungus is the one made at Greencastle, Indiana, by Deam, and the earliest mention is by Davis (1929) who identified the fungus collected at Brodhead, Wis., as *Taphrina filicina* Rostr.

5. *Taphrina californica Mix*

Taphrina californica Mix, Mycologia **30**:563-569. 1938.

Causing small to large (several centimeters in extent when swollen) orange-brown galls on leaflets, midribs, and petioles of *Dryopteris arguta* (Kaulf.) Wats. The galls are fleshy and gelatinous, becoming small, wrinkled, and hard when dry; much swollen when wet. The gall originates from the epidermis and the mycelium develops entirely within the outer walls of the surface cells ("epidermal cells") of the gall. Ascogenous cells develop in a much enlarged wall locule, and the mature asci burst forth and protrude from this locule.

Asci clavate, truncate or rounded at the apex, provided with stalk cells; ascospores usually eight, ovate to elliptic. (Fig. 1, H, I.)

Dimensions: Of *asci,* 23-46μ × 7-8μ; of *stalk cells,* 17-30μ × 5-7μ; of *spores,* 4-5μ × 2-3μ.

Distribution: California, Mexico, Oregon.

Material examined: California: Lake Phenix, Marin County, Aug. 21, 1930, Victor Duran; same locality, Sept. 4, 1930, H. E. Parks (California Fungi 343); Lee Bonar, Nov. 28, 1937 (type); Carmel, Big Sur River, June 23, 1938, C. E. Scott; Palo Alto, San

Francisquito Creek, Sept. 25, 1938, R. H. Thompson; San Mateo County, Los Altos, May 30, 1939, R. H. Thompson.

The collection by Parks was widely distributed (as California Fungi 343) under the name *Taphrina filicina* Rostr. Many subdivisions of this collection in various herbaria have been examined, but in all of them the fungus is immature, showing ascogenous cells but no asci. The galls are characteristic.

Taphrina californica is apparently common in the coastal region from lower California to central Oregon. Dr. R. H. Thompson kindly searched the collection of ferns in the Stanford University Herbarium, looking for those with unmistakable galls of *T. californica.* Ferns bearing galls were found to have been collected from the following localities: CALIFORNIA: Amador County, Cedar Creek; Marin County, Petaluma; Monterey County, above P. I. Co. Dam; Rand County, City Creek; San Diego County, East Illinois River, four miles from Takilma, seven miles above Lakeside; San Mateo County, Santa Cruz Mountains, King's Mountain; Santa Clara County, Los Gatos; Tulare County, Sequoia National Park. OREGON: Multnomah County, Elk Rock. MEXICO: Santo Tomas (Baja California).

6. *Taphrina cornu-cervi* Giesenhagen

Taphrina cornu-cervi Giesenhagen, Flora **76**:130-156. 1892.

Causing long, branched, antler-like outgrowths on leaves of *Polystichum aristatum* (Forst.) Presl.

Mycelium intercellular.

Asci covering surface of outgrowth, clavate, rounded at apex, provided with a stalk cell; ascospores eight, round, ovate or elliptic, often budding in the ascus.

Dimensions: Of *asci,* 18-24μ × 6-10μ; of *stalk cells,* 5-8μ × 5-7μ; of *spores,* 3.5-4.5μ × 2-3μ. (Giesenhagen reported asci 24μ × 5-6μ, stalk cells 4-6μ × 2-4μ, spores not present.) (Fig. 1, J.)

Distribution: Ceylon, Fiji Islands, India, Japan, Nepal, New Caledonia, Tahiti.

Material examined: FIJI: Nodarivatu, Viti Levu, May-July, 1927, H. E. Parks (Plants of V. L. F. Coll. by Bernice P. Bishop Museum and Univ. Calif.) INDIA: Nilgiri, no date, ex Herb. Sydow (in Bot. Mus. Stockholm); Coonoor, Sim's Park, Nilgiri Hills, no date (received 1939), M. O. P. Iyengar. JAPAN: Hamemura, Prov. Tosa, 1908 (ex Herb. Morioka Imp. Coll. Agric. and For.).

In addition to the preceding the following three specimens have been examined superficially. They bear no dates. They are in the Patouillard Herbarium, now owned by the Farlow Herbarium. One is labelled: "Herbarium Stendel, Pl. Indiae Or. (M. Nilgiri) Ed. R. F. Hohenacher, 901. *Roestelia tubaeformis* Rabenh, n. sp., In *Aspidio cervifolio* Kze. In montibus Nilgiri." The second: "*Taphrina tubiforme* Lagerh., Nouvelle Caledonie." The third: "*Taphrina tubiforme* Lagerh., Tahiti. Herb. Pancher." In these specimens the outgrowths are characteristic.

Giesenhagen (1892) described the fungus from material collected in Nepal and Ceylon. Sadebeck (1895) reports specimens from Queensland, Fiji, and Samoan Islands.

7. *Taphrina vestergrenii* Giesenhagen

Taphrina vestergrenii Giesenhagen, Bot. Zeit. **59**:115-142. 1901.
Exoascus vestergrenii (Gies.) Saccardo and Sydow, Sylloge Fungorum **16**:1152.

Causing small (up to 5 mm. diameter), fleshy, brownish (probably lighter colored in fresh material) galls on leaves of *Dryopteris filix-mas* Schott, and perhaps also on *D. lacera* O. Kuntze.

Mycelium subcuticular.

Asci hypophyllous or amphigenous, clavate, rounded or truncate at the apex, stalk cell pointed or truncate below.

Dimensions: Of *asci,* 23-50μ × 6-10μ; of *stalk cells,* 10-23μ × 4-10μ; of *spores,* 3.5-6μ × 2.5-4μ. Ascospores eight, round, ovate or elliptic, often budding in the ascus. The asci are closely packed and in some specimens both asci and stalk cells show an irregular contour. (Fig. 2, A.)

Distribution: Northern and Central Europe (Japan and China?).

Material examined: Denmark: Skjelskör, June 23, 1907, J. Lind. Germany: Allgau, Einödsbach, Feldhorn, July, 1909, W. Krieger; Alsace, Hohneck, Fischboedle, July 14, 1910, H. Sydow (Sydow Myc. Germ. 978); Baden, Feldhorn, Aug., 1903, G. Lagerheim. Russia: Abro Island, near Osel, July 1, 1899, T. Vestergren (Rehm. Ascomyceten, 1412, dupl. of type). Sweden: Uppland, Kuggvik, Lilla Möja, July 4, 1923, T. Vestergren.

The asci were described by Giesenhagen as 25μ × 6μ, and dimensions of the stalk cell were not given. Jankowska (1928) gave dimensions of asci as 24-35μ × 5-7μ, of stalk cells as 12-21μ × 4-6μ, and stated that stalk cells may be pointed. Spore-dimensions as given by Giesenhagen and Jankowska are 7μ×2.5-3μ.

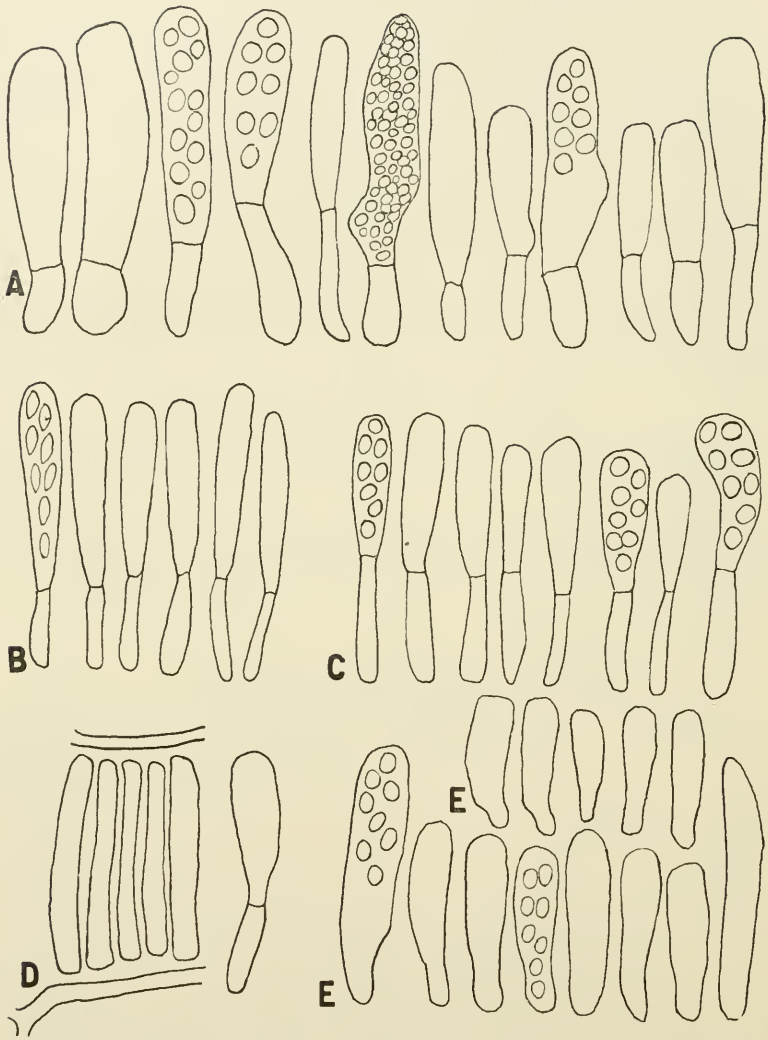

FIG. 2. Asci (× 900) of A, *Taphrina vestergrenii;* B, *T. gracilis;* C, *T. fusca;* D, *T. fusca* (Bubák's "*T. moriformis*"), ascogenous cells and one ascus; E, *T. filicina.*

Besides these specimens of the undoubted *T. vestergrenii* three specimens from the Herbarium of the Morioka Imperial College of Agriculture and Forestry have been studied, all labelled "*Taphrina vestergrenii* Giesenhagen on *Dryopteris lacera* O. Kuntze": JAPAN: Prov. Ise, Mt. Komono, Aug. 1903, K. Nakanshiki; Prov.

Kochi, Mt. Yanaze, Oct. 1904, T. Yoshinaga; Prov. Tosa, Higishikawamura, Aug. 1905, T. Yoshinaga. The galls in these specimens are overmature, and no asci can be found. The galls show greatly distorted vascular bundles, a feature not observed in the European specimens.

A specimen of a fungus on an unidentified species of *Dryopteris* collected at Mt. Omei, Szechwan, China, Aug. 3, 1928, by W. P. Fang may be *Taphrina vestergrenii*. The fungus is immature, showing only subcuticular mycelium, but the gall resembles that on *Dryopteris lacera*. The specimen in question was kindly donated by Dr. D. H. Linder, and a duplicate remains in the Farlow Herbarium.

8. *Taphrina gracilis* Mix

Taphrina gracilis Mix, Mycologia **30**:5:563-579. 1938.

Causing small (up to 5 mm. diam.) thickened areas, resembling small lesions of peach leaf curl, on leaves of *Dryopteris marginalis*, (L.) A. Gray.

Mycelium intercellular.

Asci epiphyllous or amphigenous, clavate, rounded at the apex, provided with a stalk cell; ascospores eight, fusiform.

Dimensions: Of *asci*, 26-36μ × 4-6μ; of *stalk cells*, 13-23μ × 3-4μ; of *spores*, 5-8μ × 2-2.5μ. (Fig. 2, B.)

Distribution: Labrador Lake, New York.

Material examined: Cornell Univ. Dept. Plant Path., New York Bot. Gard., Brooklyn Bot. Gard., Fungi collected near Ithaca, N. Y., June 2-7, 1919, No. 1256, Labrador Lake, Coll. E. W. Olive, A. H. W. Povah, L. R. Hesler, F. J. Seaver, H. H. Whetzel, H. M. Fitzpatrick, et al. In New York Bot. Gard. Herb. (Type). Duplicate material at the other institutions named does not show the fungus in mature condition.

Because this fungus is known only from a single meager collection the writer (l. c.) had some hesitation in describing it as a distinct species. The temptation was to consider it as a host-variant of *Taphrina fusca* (known to occur in the same locality) or of *T. vestergrenii* (not known in North America). However, the characteristic slender asci and the fusiform spores differentiate it from both these species. Moreover the gall is different from those formed by *T. fusca* and *T. vestergrenii* (q. v.), being characterized by moderate hypertrophy of all the cells of the lamina.

9. *Taphrina fusca* Giesenhagen

Taphrina fusca Giesenhagen, Flora **86**:100-109. 1899.
Exoascus fuscus (Gies.) Saccardo and Sydow, Sylloge Fungorum **16**:803.
Taphrina moriformis Bubák, Bull. Herb. Boissier, Ser. 2, **6**:393-488. 1906.

Causing small (up to 5 mm. in diam.) fleshy (convoluted when dry), yellowish galls on leaves of *Dryopteris rigida* (Hoffm.) Underw., *D. rigida* var. *australis* Christ., *D. spinulosa* (Muell.) Kuntze, *D. spinulosa* var. *americana* (Fisch.) Fern., and var. *intermedia* Underw. According to Giesenhagen (l. c.) the gall, though exhibiting considerable hypertrophy, is epidermal in origin, and this seems to be the case in the various specimens examined. Fresh material, with galls of various ages, would be necessary in order to determine this point with exactness.

Mycelium subcuticular.

Asci epiphyllous, or sometimes amphigenous, clavate, rounded or truncate at the apex, provided with a stalk cell which may equal or exceed in length the ascus proper. Ascospores globose to elliptic, sometimes budding in the ascus. (Fig. 2, C, D.)

Dimensions: Of *asci,* 19-27μ × 4-8μ; of *stalk cells,* 15-34μ × 4-7μ; of *spores,* 3.5-7μ × 2-3.5μ.

Distribution: On *Dryopteris rigida,* Albania. On *D. rigida* var. *australis,* Sicily. On *D. spinulosa* et var., eastern North America.

Material examined: Dryopteris rigida. ALBANIA: Njegusi prope Cetinje, July, 1903, F. Bubák (Bubák's type specimen of *Taphrina moriformis,* obtained on loan from Brooklyn Bot. Gard.). *D. rigida* var. *australis.* SICILY: Near Palermo, Nov. 1898, K. Giesenhagen (Giesenhagen's type specimen of *T. fusca,* obtained on loan from Univ. of Munich Herbarium). *D. spinulosa* et var. NEW BRUNSWICK: Campobello, July, 1902, W. G. Farlow (Rel. Farl. 149). NEW HAMPSHIRE: Mt. Lafayette, July 20, 1935, D. H. Linder; Mt. Washington, Tuckerman Ravine Trail, July 6, 1931, K. S. Chester and J. H. Faull (Herb. J. H. F. 9934). VERMONT: Mt. Mansfield, July 15, 1932, J. H. Faull and K. S. Chester (Herb. J. H. F. 10734). WEST VIRGINIA: Bayard July, 1891, W. C. Sturgis.

Bubák's description of *Taphrina moriformis* gives dimensions of asci as 30-45μ × 4-6μ, stalk cells not mentioned, spores not seen. The asci are further described as narrow at the apex. Examination of his type material makes it appear that he saw and described no asci but only ascogenous cells. These are long and narrow, 30-46μ × 5μ, and form a close layer beneath the epidermis (Fig. 2, D). Diligent search of the material revealed a single mature ascus with a

stalk cell and spores. Dimensions of this ascus were 33 × 10μ, of the stalk cell, 17 × 5μ, and of the spores, 4.5 × 5μ. The gall itself is somewhat larger than in other collections of *Taphrina fusca*. Judging from its dried state it may reach one centimeter in diameter when fresh, and is much convoluted. That this convolution is apparent in the fresh state may be inferred from Bubák's description and from his choice of a specific name. There is no doubt that Bubák's and Giesenhagen's fungi, occurring on the same host species, are identical.

The writer's reasons for assigning the American fungus on *Dryopteris spinulosa* to *Taphrina fusca* have been given earlier (Mix, 1938).

The yellowish or brownish coloration of the galls is found in the walls of the outer cells ("epidermal cells"), all fungous structures being hyaline.

10. *Taphrina filicina* Rostrup ex Johanson

Taphrina filicina Rostrup ex Johanson, Bih. Kongl. Vetensk. Akad. Handl. **13**:3-28. 1887.
Ascomyces filicinus Rostrup, Vestergren, Micr. Rar. Sel. No. 813.
Exoascus filicinus (Rostr.) Saccardo, Sylloge Fungorum **8**:819.

Causing thickened areas of the leaf-curl type or small fleshy galls on leaves of *Dryopteris spinulosa* (Muell.) Kuntze, *D. spinulosa* var. *americana* (Fisch.) Fern., and var. *intermedia* Underw. As pointed out by Giesenhagen (1899) the gall is not epidermal in origin, but all leaf tissues are involved.

Mycelium intercellular.

Asci amphigenous, clavate, rounded at the apex, attenuate at the base, lacking a stalk cell. Ascospores ovate to elliptic. (Fig. 2, E.)

Dimensions: Of *asci,* 18-46μ × 6-10μ; of *spores,* 3.5-6.5μ × 2-3.5μ.

Distribution: northern Europe and eastern North America.

Material examined: Germany: Tirol, Sondestal, Geschnitztal, Aug., 1939, F. Wettstein. Russia: Prov. Novgorod, Beresaida, July, 1890, W. Tranzschel (Jaczewski, Komarov, Tranzschel. Fungi Rossiae Exsiccati, 27). Sweden: Dalarna, Avesta, Elfnäshage, July, 1879, Conrad Indebetou (duplicate material from the type-collection, Bot. Mus. Stockholm.) Poland: Kraków, no date, Raciborski (Ex Herb. A. Wróblewski). New York: Ithaca, Enfield Gorge, July 14, 1917, J. H. Faull (Herb. J. H. F., 1804); *ibid,* July 14, 1917, L. B. Walker; Coy Glen, July 3, 1927, L. B. Walker; McLean, McLean Preserve, July 25, 1937, W. W. Ray (Herb. W. W. R. 371). Pennsylvania: Mt. Jewett, McKean Forest, July 7, 1938, A. E. Edgecombe and L. O. Overholts (Ex. Herb. L. O. O.).

The wide range of variation in ascus size between European and American specimens of this fungus has already been pointed out (Mix, 1938). Many specimens of other species of *Taphrina* in American herbaria are wrongly labelled *T. filicina,* American collectors having referred fern-inhabiting species of *Taphrina* to this species indiscriminately. Such specimens have been properly allocated in the present account without, however, mention in every case of the mistaken identification.

Jaczewski (1926) mentions Russian specimens of *Taphrina filicina* on "*Nephrodium, Phegopteris,* and *Athyrium filix-femina.*" It has not been possible to obtain these specimens for study.

11. *Taphrina thaxteri* Mix

Taphrina thaxteri Mix, Mycologia **31**:4:445-454. 1939.

Causing pale yellowish unthickened spots, one centimeter or more in extent, on leaves of *Dryopteris poiteana* (Bory) Urban.

Mycelium growing within the epidermal wall.

Asci hypophyllous, protruding from a wall locule, clavate, rounded at the apex, provided with a stalk cell; ascospores eight, often fusiform. (Fig. 3, A, B, C.)

Dimensions: Of *asci,* 20-27μ × 5-7μ; of *stalk cells,* 7-15μ × 5-7μ; of *spores,* 3.5-5μ × 2-3μ.

Distribution: Trinidad.

Material examined: TRINIDAD: Arima: Verdant Vale, no date, R. Thaxter (Herb. Roland Thaxter, "Bequest 1932").

12. *Taphrina fasciculata* (Lagerh. and Sadeb.) Giesenhagen

Taphrina fasciculata (Lagerh. and Sadeb.) Giesenhagen, Flora **81**:267-361. 1895.
Magnusiella fasciculata Lagerheim and Sadebeck, Ber. Deutsch. Bot. Ges. **13**:265-280. 1895.

Causing small unthickened spots with a grayish or whitish ascus-bearing center, and a narrow pale yellowish margin (thus resembling spots caused by *T. lutescens*) on leaves of *Dryopteris* sp. (*D. filix-mas*?).

Mycelium intercellular.

Asci short-clavate and provided with a short stalk cell, or long-clavate with a long stalk cell, or arising from a two-celled or three-celled hypha. The longer asci with longer stalk cells are frequently empty, having discharged their spores. The basal cell of a two-celled or three-celled stalk often has a bent foot. Ascospores eight, ovate to elliptic. (Fig. 3, D.)

Dimensions: Of *asci,* 20-53μ × 8-10μ; of *stalk cells,* 10-66μ ×

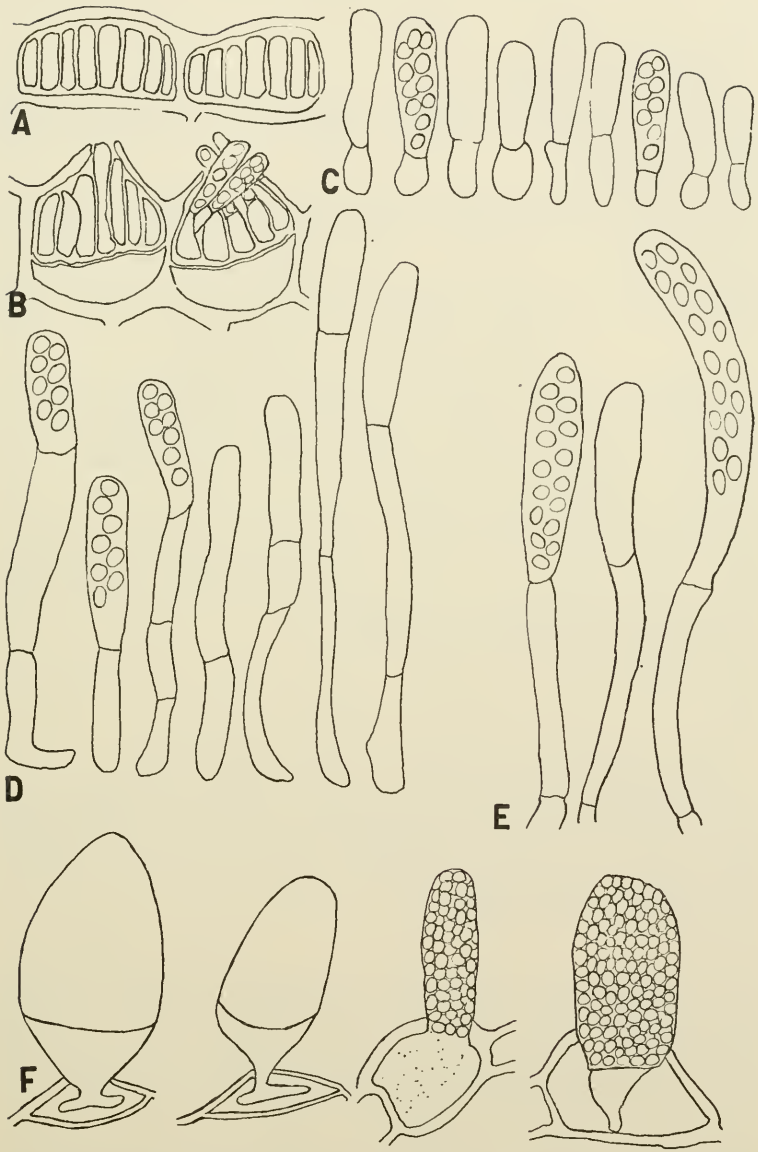

FIG. 3. A, B, C, *Taphrina thaxteri;* A, Ascogenous cells in wall locule; B, Asci emerging from locule; C, Asci. D, Asci of *T. fasciculata;* E, of *T. ecuadorensis;* F, of *T. osmundae.* All × 900.

7-8μ; of second or third cells of septate *stalk,* ca. 40μ × 7μ; of *spores,* 5-7μ × 2.4-4μ.

Distribution: Ecuador.

Material examined: ECUADOR: Quito, Rio Machángara, no date, Lagerheim, det. Sadebeck (Herb. Reg. Monac.). Type specimen. Munich Museum.

The inner packet containing this material bears the following, presumably by Sadebeck: "*Magnusiella Nephrodii* Lagerh. in herb., bildet kleine weissliche oder graüliche nicht blasige flecken auf *Nephrodium* (*filix-mas*). Trotz vielem suchen nur an einen standort und nur an einem wedel beobachtet. Der standort war sehr feucht und schattig. Rio Machángara bei Quito, Leg. G. v. Lagerheim. Am nächsten mit *M. lutescens* verwandt, hat jedoch lang keulige asken mit eiformigen sporen (keine conidien), ähnelt daher M. potentillae." In another handwriting is added: "*Magnusiella fasciculata* v. Lagerheim and Sadebeck."

Sadebeck gives dimensions of the asci as 50-70μ × 9-12μ, and states that a stalk cell is present which is narrower than the ascus. These dimensions are hard to understand unless Sadebeck included stalk cell and ascus in his measuring.

It is impossible to determine the host species from the material available.

13. *Taphrina ecuadorensis* Sydow

Taphrina ecuadorensis Sydow, Ann. Myc. 37:275-438. 1939.

Causing small (1.5 to 3 mm. diam.) yellowish to yellow brown (with whitish central area bearing asci and narrow margin) unthickened or only slightly thickened spots on leaves of *Dryopteris cheilanthoides* (Kze.) C. Chr.

Mycelium intercellular, abundant (stated to be subcuticular by Sydow).

Asci cylindric, clavate, rounded at apex, borne on the ends of septate hyphae, which often arise from a rather dense weft of mycelium (in this habit resembling *Taphrina potentillae*). The asci form dense tufts, pushing up through the epidermis and rupturing it. Ascospores eight, elliptic to fusiform. (Fig. 3, E.)

Dimensions: Of *asci,* 23-40μ × 6-10μ; of *mycelial cell* next to ascus (corresponding to stalk cell), 23-56μ × 4-7μ; of *spores,* 4-6.5μ × 2-2.5μ.

Distribution: Ecuador.

Material examined: ECUADOR: Tungurahua: Hacienda San An-

tonio pr. Baños, Dec. 31, 1937, H. Sydow (Fungi Aequatoriensis 651). Part of type, obtained from Sydow.

Sydow wrote that he found the fungus "somewhat difficult to study," which is indeed the case. He does not report the intercellular mycelium nor the rupturing of the host epidermis by the compact tufts of asci, though he describes the asci as crowded ("dense conferti"). Neither does he mention that the asci arise from the ends of septate hyphae, but describes a stalk cell ("in matricem non penetrante"), 20-35μ × 4-6μ.

This species is probably synonymous with the preceding but sufficient material is not at hand to demonstrate it.

14. *Taphrina osmundae* Nishida

Taphrina osmundae Nishida, Miyabe Festschrift, Tokyo, **1911**:157-212.

Causing small to large, yellowish to light brown, unthickened spots (sometimes involving the whole leaflet), on leaves of *Osmunda regalis* (L.) var. *japonica* Willd. A sparse white powdery layer of asci covers the lower surface of the spot and less commonly smaller areas occur on the upper surface.

Mycelium developing within outer walls of epidermal cells, forming wall locules, each of which contains a single ascogenous cell.

Asci hypophyllous, less commonly also epiphyllous, scattered, one ascus formed in each wall locule, emerging as a small papilla which gradually enlarges to an oblong ascus, a small, triangular stalk cell remaining inserted in the locule. Ascospores not seen, blastospores numerous, often forming in the ascogenous cell (young ascus) before ascus emergence; in mature asci the blastospores occur in a peripheral layer close to the wall. (Fig. 3, F.)

Dimensions: Of *asci,* 26-63μ × 17-27μ; of *stalk cells,* 6-17μ × 8-17μ; of *spores* (blastospores), 3-4μ × 2-3.5μ.

Distribution: Japan.

Material examined: Japan: Pref. Tottori, Taisenji, July 1, 1924, K. Togashi (Herb. Morioka Imp. Coll. Agric. and For. 193); Pref. Iwate, Mt. Iwate, June 13, 1934, K. Togashi (Herb. Morioka Imp. Coll. Agric. and For.); Kyûsû, Mt. Kirisama, May 29, 1938, I. Hino (Herb. Lab. Path. Veg. Miyazaki Kôtô Norni-Gúkko).

In early stages a network of small-celled hyphae forms within the epidermal wall, and haustoria are sent into the cell cavity beneath. Ultimately each wall locule contains a single multinucleate hyphal body, with a thin membrane. From this ascogenous cell a single ascus arises as explained above. The intermediate development is not clear, and it has not been possible to trace the

nuclear history from the rather scanty herbarium material at hand. Cytological study of this fungus would be very desirable, since, if the interpretations here given are correct, it is a highly aberrant species, showing some resemblance to members of the genus *Taphridium* Lagerh. and Juel.

Although Nishida's paper is in Japanese, it may be assumed from his English summary and from his figure that he missed the features described above ("wall habit" of mycelium, emergence of asci, presence of a pedicellate stalk cell).

15. *Taphrina higginsii* Mix

Taphrina higginsii Mix, Mycologia **39**:71-76. 1947.

Causing small (up to 5 mm. diam.) yellowish unthickened spots on leaves of *Osmunda cinnamomea* L.

Mycelium developing within outer epidermal wall, occasionally forming unspecialized haustoria which project into the cell cavity. A multinucleate hyphal element (ascogenous cell) forms in each wall locule, from which a single ascus emerges. Ascospores not seen. Numerous spores (blastospores) appear in a peripheral layer in the ascus before, during, or after emergence.

Asci hypophyllous or amphigenous, oblong-cyclindric, rounded at apex, with a narrower cyclindric stalk cell, the lower part of which is expanded into a foot within the wall locule. (Fig. 4, A.)

Dimensions: Of *asci*, 40-80μ × 13-23μ; of *stalk cells*, 10-17μ × 8-10μ; of *spores*, 2-5μ × 1.5-4μ.

Distribution: Georgia.

Material examined: GEORGIA: Hamilton, Pine Mountain, Blue Springs Farm, May 26, 1938, B. B. Higgins.

This fungus, for which the writer is indebted to B. B. Higgins, differs from *Taphrina osmundae* by its larger asci, and its narrow, nearly cyclindric stalk cell. It also causes smaller spots, as is natural on the more finely dissected fronds of the host. Like *T. osmundae* it would repay cytological study.

An earlier collection made by W. A. Murrill at Blacksburg, Va., in 1897 could not be positively identified as *T. higginsii*. An account of this has been previously given (Mix, 1947).

16. *Taphrina polystichi* Mix

Taphrina polystichi Mix, Mycologia **30**:563-579. 1938.

Causing small to large (up to 1 cm. diam.) yellowish or yellow-brown thickened spots on leaves of *Polystichum acrostichoides* (Michx.) Schott.

Mycelium intercellular.

Asci epiphyllous, occasionally also hypophyllous, crowded, clavate, rounded at apex, provided with a stalk cell, ascospores usually eight, ovate to elliptic, sometimes budding in the ascus. (Fig. 4, C.)

Dimensions: Of *asci*, 23-53μ × 4.5-8.5μ; of *stalk cells*, 13-23μ × 4-7μ; of *spores*, 3-6μ × 2-4μ.

Distribution: eastern North America.

Material examined: New York: McLean, McLean Bog, July 5, 1940, A. J. M.; Oneida, June 10, 1935, H. D. House; Ringwood, July 23, 1940, A. J. M. North Carolina: Durham, 1935, F. A. Wolf; Nantahala Gorge, May 29, 1941, A. J. M. Ohio: Hamilton Co., 1934, Wm. Bridge Cooke. Pennsylvania: Lycoming Co., Trout Run, June 6, 1925, L. O. Overholts and L. T. Deniston (Herb. L. O. O. 9839). Tennessee: Cades Cove, May 30, 1937, L. R. Hesler. West Virginia: Bayard, July, 1891, W. C. Sturgis.

This is the most frequently collected and apparently the most common and widely distributed fern-inhabiting species of *Taphrina* in North America. It occurs throughout the eastern United States and adjacent Canada. The first collection is that made by Sturgis in West Virginia in 1891, and the first mention in literature is that by Coker (1910) who called the fungus *Exoascus filicinus*.

17. *Taphrina wettsteiniana* Herzfeld

Taphrina wettsteiniana Herzfeld, Oesterreich Bot. Zeitschr. **60**:249-254. 1910.

Causing small (up to 8 mm. diam.) roundish, well-defined, lemon-yellow (brown in age) slightly thickened spots on under surfaces of leaves of *Polystichum lonchitis* (L.) Roth. Spots scarcely visible on the upper surface or only as a paler area.

Mycelium intercellular.

Asci hypophyllous or amphigenous, clavate, rounded at apex, with or without a stalk cell; ascospores eight, fusiform or slightly curved, usually with two globules. (Fig. 4, B.)

Dimensions: Of stalkless *asci*, 32-53μ × 6-10μ; of stalked *asci*, 25-38μ × 6-10μ; (17-23μ × 5-7μ according to Herzfeld); of *stalk cells*, 6-13μ × 5-8μ; of *ascospores*, 4.5-6.5μ × 2-4μ. (Blastospores may be elongate and bacterioid, 5 × 1μ.)

Distribution: Tyrol.

Material examined: Tyrol: Sondestal ("sistendal des Geschniztel, loc. class.") Aug., 1939, Fr. Wettstein.

Herzfeld, who described the fungus while working at Munich under the direction of R. Wettstein, apparently designated no type

specimen. On inquiry at the Munich Museum it was learned that preserved material of Herzfeld's collection was known to have been in the museum but in 1938 it could not be found. However in 1939, Dr. Fr. Wettstein kindly obtained fresh material from the place of original collection and sent it to the writer. This material, deposited in the Mycological Herbarium, University of Kansas, is chosen as the lectotype.

Although the mycelium is intercellular, very little modification of the mesophyll occurs. The epidermis is browned.

18. *Taphrina faulliana* Mix

Taphrina faulliana Mix, Mycologia **30**:563-579. 1938.

Causing small (up to 5 mm. diam.) round to oval, lemon-yellow (brown in age or on drying) slightly thickened spots on leaves of *Polystichum munitum* (Kaulf.) Presl.

Mycelium subcuticular.

Asci hypophyllous, sometimes also epiphyllous, closely packed, long-clavate, provided with a stalk cell. Ascospores not yet observed, blastospores numerous, long-elliptic to bacilliform. (Fig. 4, D.)

Dimensions: Of *asci,* 43-76μ × 6-9μ; of *stalk cells,* 13-33μ × 4-7μ; of *blastospores,* 4.5-6.5μ × 1.5-2μ.

Distribution: Oregon, British Columbia.

Material examined: OREGON: Zigzag Mountain Trail, July 9, 1929, G. D. Darker (Arnold Arboretum, Path. Herb. 186); Rhododendron, Sept. 6, 1931, J. R. Hansbrough (Herb. J. R. H. 614). BRITISH COLUMBIA: Vancouver Island, Sidney or Lake Cowichan, June, 1938, Malcolm Wilson.

In the original description of this fungus the spots are described as brown. This must have been due to age of material since in the freshly collected material received in 1938 from Malcolm Wilson, the spots were, as he kindly pointed out, lemon-yellow in color. The width of asci (4-7μ) given in the original description is in error. Examination of the measurements recorded at the time of describing shows the width to be 6-9μ as given above. Other revisions in dimensions (of stalk cells and conidia) result from study of additional material.

The fungus was named in honor of Dr. J. H. Faull, from whom it was first received. The first collection, apparently, was that of Darker in 1929.

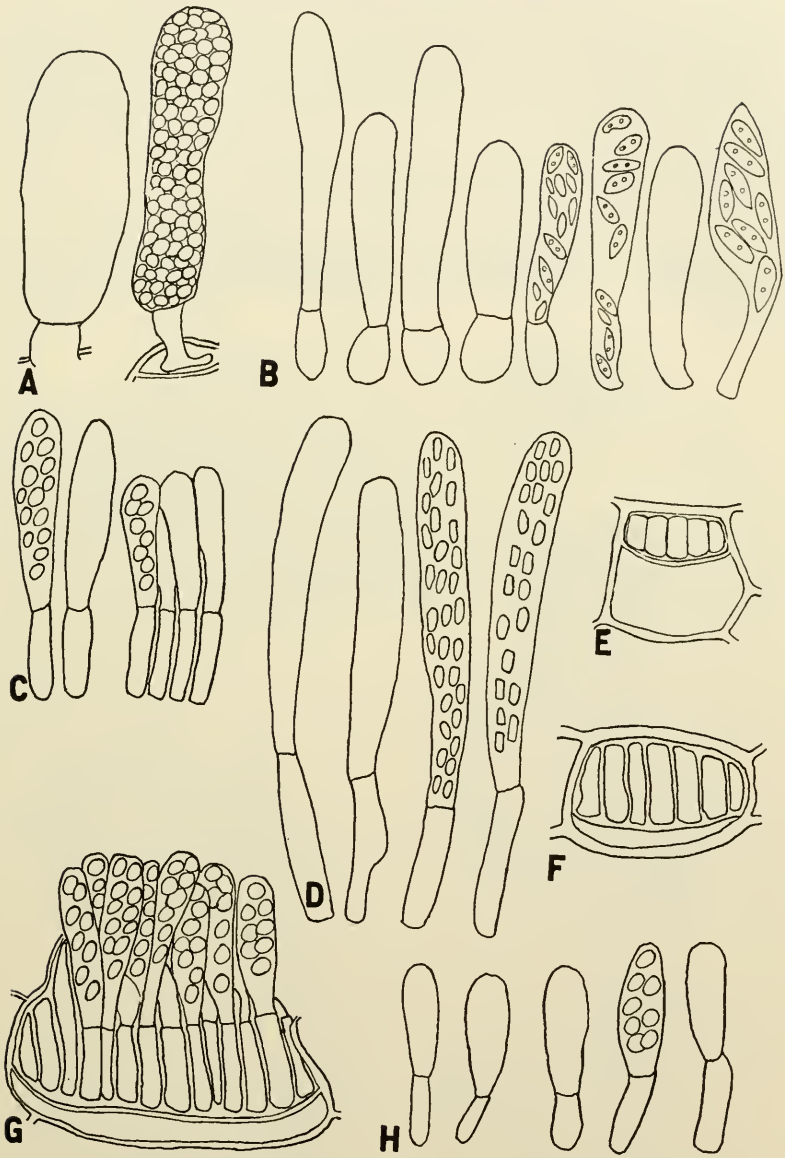

FIG. 4. Asci (×900) of A, *Taphrina higginsii;* B, *T. wettsteiniana;* C, *T. polystichi;* D, *T. faulliana;* E-H, *T. tonduziana;* E, F, ascogenous cells in wall locules; G, emerging asci; H, asci.

19. *Taphrina tonduziana* P. Hennings

Taphrina tonduziana P. Hennings, Beibl. z. Hedwigia, **41**:101-105. 1902.

Causing small (up to 5 mm. diam.) brown (with central areas whitish by presence of asci) unthickened spots on leaves of *Pteris spinosa* (L.) Desv.

Mycelium growing within the epidermal wall.

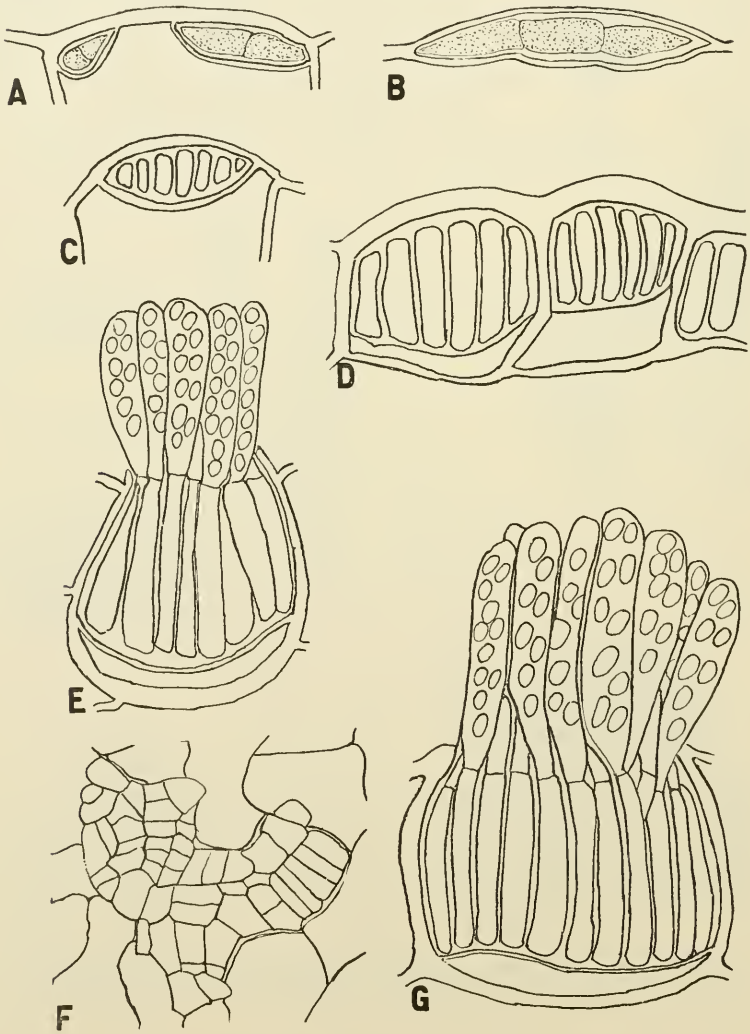

FIG. 5. A-E, *Taphrina laurencia*. A, B, mycelium in wall locule; C, D, ascogenous cells; E, asci, in wall locule; F, ascogenous cells (viewed from above), G, asci of *T. rhomboidalis*. All × 900.

Asci amphigenous, emerging from wall locules, clavate, provided with a stalk cell. Ascospores eight, long-elliptic to fusiform. (Fig. 4, E-H.)

Dimensions: Of *asci,* 20-33μ × 7-8μ; of *stalk cells,* 10-23μ × 4-7μ; of *spores,* 4-7μ × 2-3μ.

Distribution: Costa Rica.

Material examined: Costa Rica: San José, 1900, leg. A. Tonduz, comm. P. Hennings (Rehm, Ascomyceten 1461).

The errors in the original description by Hennings have already been corrected and discussed (Mix, 1938), and the "wall habit" of the fungus described.

20. *Taphrina laurencia* Giesenhagen

Taphrina laurencia Giesenhagen, Flora **76**:130-156. 1892.

Causing remarkable, much branched, fine, bushy outgrowths on fronds of *Pteris quadriaurita* Retz.

Mycelium growing within the epidermal wall.

Asci amphigenous, emerging from wall locules, provided with a stalk cell. Ascospores oval to elliptic. (Fig. 5, A-E.)

Dimensions: Of *asci,* 23-33μ × 6-9μ; of *stalk cells,* 17-30μ × 4-7μ; of *spores,* 5-7μ × 2-4μ.

Distribution: Ceylon.

Material examined: Ceylon: Hakgala, March, 1914, T. Petch; Perideniya, 1912, T. Petch (Ex. Herb. Rehm). India: G. Smith (Ex. Herb. Sydow).

The correction of Giesenhagen's report that asci form within the epidermal cells has been made earlier (Mix, 1938). Giesenhagen did not find spores when describing the fungus but later (1901) reported them to be in size near those of *Taphrina vestergrenii.* Spores were present in the material examined by the writer.

21. *Taphrina rhomboidalis* Sydow and Butler

Taphrina rhomboidalis Sydow and Butler, Ann. Myc. **9**:372-421. 1911.

Causing small yellow (becoming brown with age) rhomboidal unthickened spots on leaves of *Pteris quadriaurita* Retz.

Mycelium growing within the epidermal wall.

Asci amphigenous, emerging from wall locules, provided with a stalk cell; ascospores eight, ovate to elliptic. (Fig. 5, F, G.)

Dimensions: Of *asci,* 23-43μ × 8-10μ; of *stalk cells,* 23-43μ × 4-5μ; of *spores,* 4-7μ × 2-3.5μ.

Distribution: Northern India.

Material examined: Himalaya: Kumaon, Barma Gori Valley, June 24, 1907, Inayat Khan. Det. E. J. Butler. (Imp. Agric. Res.

Inst. I. 47.) Received from G. Watts Padwick, Imp. Agric. Res. Inst. New Delhi, India.

The rhomboidal shape of the lesion is due to its being margined by veins, though commonly more than one vein-islet is included. The "wall habit" of the fungus, not fully described by the original authors, has been discussed earlier (Mix, 1939) as well as the differences between this species and the preceding. These are: the production of unthickened spots instead of branched outgrowths, the irregular, rather than polyhedral, outline of ascogenous cells when viewed from above, and the possession by the ascus of a somewhat narrower stalk cell.

22. *Taphrina amplians* Mix

Taphrina amplians Mix, Mycologia 31:445-454. 1939.

Causing marked enlargement, but no thickening, of pinnae or pinnules of *Pteris orizabe* Mat. and Gal. Affected areas becoming golden-brown.

Mycelium growing within the epidermal wall.

Asci amphigenous, emerging from wall locules, golden-yellow before maturity, and containing yellow material in epiplasm after spore formation, provided with a stalk cell; ascospores eight, ovate to elliptic. (Fig. 6. A, B.)

Dimensions: Of *asci,* 26-36μ × 8-10μ; of *stalk cells,* 23-40μ × 5-8μ; of *spores,* 5-6.5μ × 2-3μ.

Distribution: Guatemala.

Material examined: GUATEMALA: Quetzaltenango: Santa Maria de Jésus, Dec. 28, 1936, J. H. Faull (Herb. J. H. F. 12939).

In studying material of *Taphrina uleana* (P. Henn.) Gies. the writer was struck with the similarity of the healthy fronds of the host to those of *Pteris orizabe,* and of the resemblance of the lesions to those caused by *T. amplians.* This raised the question whether the two hosts and perhaps the two fungi might be identical.

The ferns were submitted to C. A. Weatherby of the Gray Herbarium, who compared them with authentic herbarium-specimens. The host for *Taphrina uleana* is not *Pteris decurrens* Presl. as reported by Hennings but *Pteris deflexa* Lk. *Pteris deflexa* and *Pteris orizabe* are distinct, though closely related species, with different geographical distribution.

The following specimens of *Taphrina uleana* were carefully studied: 1. Museum botanicum Berolinense. E. Ule. Herbarium Brasiliense No. 3076. *"Taphrina (Exoascus) Uleana* P. Henn. Auf *Pteris decurrens,* Estado de Rio de Janciro, wald bei Tijuca, Marz.

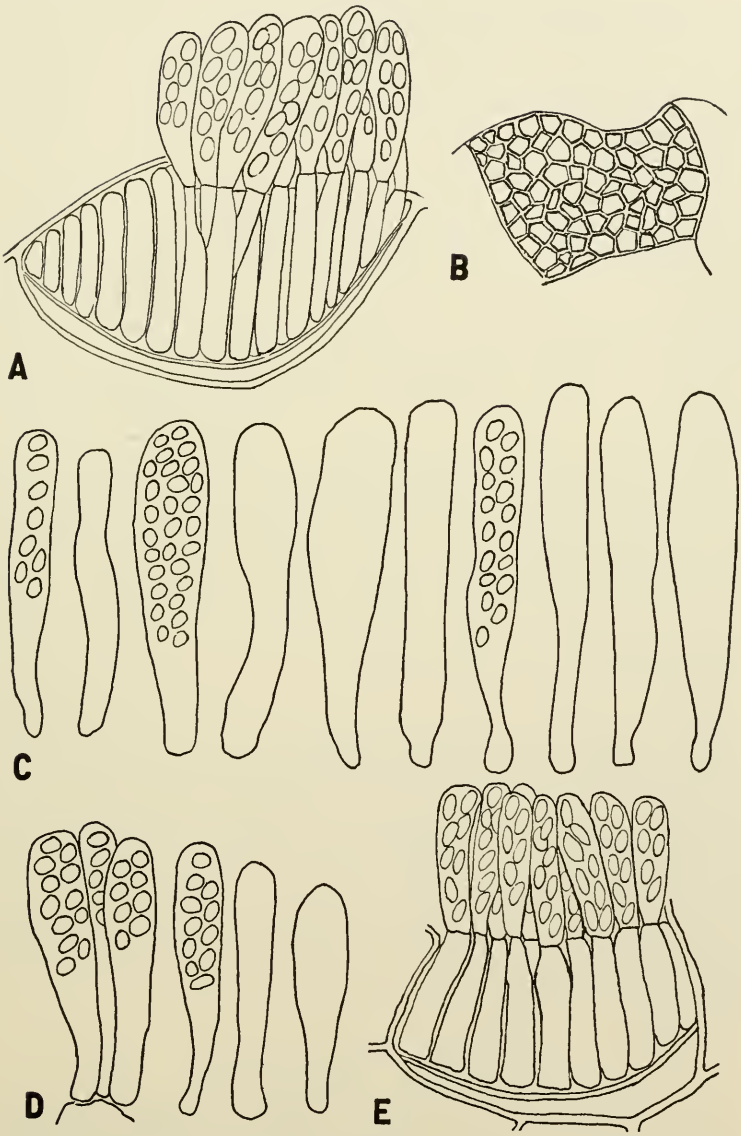

FIG. 6. A, Asci, B, ascogenous cells (from above) of *Taphrina amplians;* C, D, asci of *T. lutescens;* E, asci of *T. pteridis* in wall locule. All × 900.

1900. leg. E. Ule. Typus!" 2. Six packets of: Mycotheca brasiliensis, No. 86, "*Taphrina uleana* P. Henn. in pterid. decurr. Rio de Jan. Tijuca, 1900 E. Ule." Three of these packets were seen in the Farlow Herbarium and three in the Botanical Museum, Stockholm. One of the packets in the Farlow Herbarium is further designated, "Ex. Museo. Botanico Berolinense. Original."

The herbarium-sheet bearing the packet of type material (1, above) has affixed to it a portion of Henning's paper (1904) giving a short Latin diagnosis, and a German description, translated as follows: "Whole leaves or large areas affected by the fungus, they are at first thin membranous, yellowish, later thicken somewhat and become stiff and dirty brown. Unfortunately could only find occasional asci with ripe spores, therefore possible that size of asci may be different: Not precluded that the species better placed in *Taphrina.*"

Most of this material is abominable. It gives the appearance of having been wet and then dried without pressing. The type material is the worst of all. In one of the packets in the Farlow Herbarium the healthy portions of the fronds are well preserved and it can be seen that the diseased areas are enlarged, but not thickened, and browned. This, together with the description quoted above, suggests that *Taphrina amplians* and *T. uleana* may be similar fungi.

Thorough study of all available material of *T. uleana* has failed to reveal any mycelium or asci of *Taphrina,* any wall locules (even empty) such as are produced by *T. amplians,* anything in fact, but empty host cells and spores and mycelium of various molds. Study of the type specimen was made before writing the description of *T. amplians;* of the other specimens later. It seems posisble that the writer may have described (as *T. amplians*) a fungus related to or even identical with *T. uleana.* Since, however, the type specimen of *Taphrina uleana* does not show any recognizable fungus, *Taphrina uleana* must be declared a *nomen dubium.*

23. *Taphrina pteridis* Viégas

Taphrina pteridis Viégas, Bragantia 4:5-392. 1944.

Causing small (3-4 mm. diam.) round to elliptic (sometimes angular) yellowish to brown, necrotic spots on leaves of *Pteris* sp.

Mycelium growing within the epidermal wall.

Asci amphigenous, clavate, rounded at apex, emerging from wall locules; stalk cells cylindric; ascospores eight, elliptic. (Fig. 6, E.)

Dimensions: Of *asci,* 16-26μ; *stalk cells,* 8-20μ × 6-7μ; of *ascospores,* 4-7μ × 2.5-3μ.

Distribution: Campinas, São Paulo, Brazil.

Material examined: Brazil: São Paulo, Campinas, Bosque dos Jequitibas, June 12, 1943, A. P. Viégas and R. O. Botero (part of type, received from Viégas).

The mycelium of this fungus is not subcuticular, as stated by Viégas (l. c.), but develops within the epidermal wall, the mature asci protruding from a wall locule.

24. *Taphrina lutescens* Rostrup

Taphrina lutescens Rostrup, Meddel. Naturh. Foren. **1890**. 246-264.
Magnusiella lutescens (Rostr.) Sadebeck. Jahrb. Hamburg Wissensch. Anst. **10**:5-110. 1893.

Causing small (up to 3 mm. diam.) pale yellow unthickened spots (the central portion becoming covered with a layer of asci), on leaves of *Thelypteris thelypteris* (L.) Nieuwl.

Mycelium intercellular.

Asci hypophyllous, clavate, rounded at apex, lacking a stalk cell; ascospores eight, ovate to elliptic, commonly budding within the ascus, filling it with bacterioid blastospores. (Fig. 6, C, D.)

Dimensions: Of *asci,* 27-75μ × 5-11μ (average 40μ × 7μ); of *ascospores,* 3-6μ×2-4μ (average 4μ×2.6μ); of *blastospores,* 1.5-3μ× 1.5-2μ.

Distribution: northeastern United States and adjacent Canada, northern Europe.

Material examined: Maine: York, Aug., 1897, R. Thaxter. New York: Shelter Island, Aug., 1901, Herb. W. G. Farlow. Wisconsin: Madison, July 20, 1943, H. C. Green. Denmark: Seeland, Gjorslev, July, 1889, E. Rostrup; Lyngby, July, 1909 (received from J. Dearness). Germany: Schleswig-Holstein, Pugum near Glucksberg, July 13, 1908, O. Jaap (Fungi sel. exsicc. 304); Zahlendorf near Berlin, Sept., 1901, Sydow (Rehm, Ascomycetes 1413). Latvia: Leinzale, Milskabe, Aug. 5, 1934, A. Kirulis (Fungi latvici 652).

HOST INDEX TO SPECIES OF *TAPHRINA* ON FERNS

Athyrium filix-femina Roth.
  Taphrina athyrii Siemaszko
Blechnum sp.
  Taphrina blechni Bresadola ex Mix
Cystopteris fragilis (L.) Bernh.
  Taphrina cystopteridis Mix
Dryopteris arguta (Kaulf.) Wats.
  Taphrina californica Mix
Dryopteris cheilanthoides (Kze.) C. Chr.
  Taphrina ecuadorensis Syd.
Dryopteris filix-mas Schott.
  Taphrina vestergrenii Gies.

Dryopteris lacera O. Kuntze.
Taphrina vestergrenii Gies.
Dryopteris marginalis (L.) A. Gray.
Taphrina gracilis Mix
Dryopteris poiteana (Bory) Urban
Taphrina thaxteri Mix
Dryopteris rigida (Hoffm.) Underw.
Taphrina fusca Gies.
Dryopteris rigida var. *australis* Christ.
Taphrina fusca Gies.
Dryopteris spinulosa (Muell.) Kuntze
Taphrina athyrii Siemaszko
Taphrina filicina Rostr. ex Johans.
Taphrina fusca Gies.
Dryopteris spinulosa var. *americana* (Fisch.) Fern.
Taphrina filicina Rostr. ex Johans.
Taphrina fusca Gies.
Dryopteris spinulosa var. *intermedia* Underw.
Taphrina filicina Rostr. ex Johans.
Taphrina fusca Gies.
Dryopteris sp.
Taphrina fasciculata (Lagerh. and Sadeb.) Gies.
Onoclea sensibilis L.
Taphrina hiratsukae Nishida
Osmunda cinnamomea L.
Taphrina higginsii Mix
Osmunda regalis L.
Taphrina osmundae Nishida
Polystichum acrostichoides (Michx.) Schott.
Taphrina polystichi Mix
Polystichum aristatum Presl.
Taphrina cornu-cervi Gies.
Polystichum lonchitis (L.) Roth.
Taphrina wettsteiniana Herzf.
Polystichum munitum (Kaulf.) Prsl.
Taphrina faulliana Mix
Pteretis nodulosa (Michx.) Nieuwl.
Taphrina hiratsukae Nishida
Pteretis struthiopteris (L.) Todaro
Taphrina hiratsukae Nishida
Pteris orizabe Mat. and Gal.
Taphrina amplians Mix
Pteris quadriaurita Retz.
Taphrina laurencia Gies.
Taphrina rhomboidalis Syd. and Butl.
Pteris spinosa (L.) Desv.
Taphrina tonduziana P. Henn.
Pteris sp.
Taphrina pteridis Viégas
Thelypteris thelypteris (L.) Nieuwl.
Taphrina hiratsukae Nishida
Taphrina lutescens Rostr.

II. SPECIES ON SALICACEAE

Populus and *Salix*

25. *Taphrina populina* Fries

Taphrina populina Fries, Syst. Mycol. 3:520. 1832.
Taphrina aurea auct.
Exoascus populi Thümen, Hedwigia 13:97-98. 1874.
Exoascus aureus Sadebeck, Jahrb. Hamburg. Wissensch. Anst. 1:93-124. 1884.
Exoascus flavo-aureus Cocconi, Mem. R. Accad. Sci. Inst. Bologna 4:187-198. 1894.

Causing golden yellow, convex-concave spots, often small (5-10 mm. diam.), but sometimes confluent and large, involving half or nearly all of leaf blade, on *Populus angulata* Ait., *P. balsamifera* L., *P. berolinensis* Dipp., *P. ciliata* Wallr., *P. generosa* Henry, *P. laurifolia* Ledb., *P. nigra* L., *P. nigra* L. var. *italica* Dur., *P. petrowskyana* Schneid., *P. rasomowskyana* Schneid.

Mycelium intercellular.

Asci variable in form, cylindric or clavate, rounded or truncate at the apex, narrowed toward the base. Stalk cell present or absent, variable in form, often triangular, wedge-shaped, or bluntly rounded. Asci inserted between epidermal cells for as much as one-third of their lengths. Asci when young with yellow oily contents, large yellow globules persisting after spore formation. Ascospores rarely seen; then commonly four, budding immediately so that mature asci are filled with numerous blastospores. (Fig. 7, A-E, Fig. 8, A-C.)

Dimensions: Of *asci,* 30-122μ × 13-30μ; of *stalk cells* (when present) 4-27μ × 8-23μ; of *ascospores,* 4-6.5μ×4-5μ; of *blastospores,* 2-3μ × 2.5-1.5μ. Minute bacterioidal blastospores occasionally seen.

Distribution: widely distributed in Europe, locally throughout eastern North America, occasionally western North America, known also from India, China, and Japan.

Material examined: Populus angulata. Germany: Brandenburg, Späthsche Baumschulen zu Rixdorf b. Berlin, July 24, 1903, H. and P. Sydow (Myc. Germ. 28).

P. balsamifera. ibid. (Myc. Germ. 28.) Norway: Akershus, Ås, 1885, F. Werenskiold.

P. berolinensis. Iowa: Ames, June 20, 1892, Pammel and Stewart (as on *P. "certinensis"*). Norway: Akershus, Finsen in Aker (in nursery), Sept. 10, 1931, I. Jørstad.

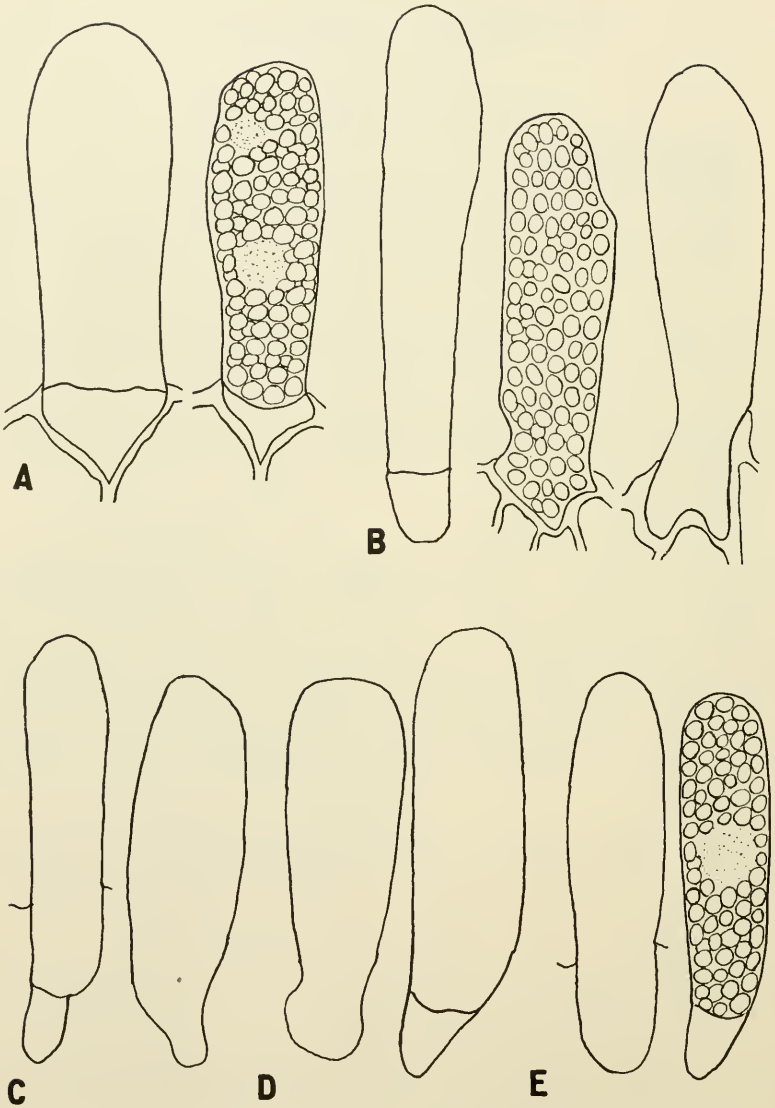

FIG. 7. Asci (× 900) of *Taphrina populina*. A, on *Populus angulata;* B, *P. balsamifera;* C, *P. berolinensis;* D, *P. ciliata;* E, *P. generosa.*

P. ciliata. India: Murree, July 20, 1908, E. J. Butler (Herb. Crypt. Orient. Fungi).

P. generosa. Norway: Akershus, Ås (in nursery) June 15, 1925, I. Jørstad. Scotland: Murthly, July 15, 1925, J. S. Boyce (Herb. J. S. B. 1565a); *ibid.* (Herb. J. S. B. 1565b).

P. nigra. Iowa: Ames, June 20, 1892 (as on *P. "betulifolia"*). Washington: Bremerton, July 20, 1912, E. Bartholomew (Fungi Columb. 4488). West Virginia: Hillsboro, June 11, 1935, C. R. Orton (as on *P. "nigra* var. *babylonica"*). Austria: between Mossbrunnen and Marienthal, June, von Höhnel (Mus. Palat. Vindob. Krypt. Exsicc. 1718). Italy: Venezia (Myc. Ital. 533). Poland: Skiernewice, July 5, 1923, Z. Zweigboumawna. Scotland: Murthly, July 15, 1925, J. S. Boyce (Herb. J. S. B. 1565c). Sweden: Skåne: Ystad, Bergsjöholmgård, July, 1939.

P. nigra var. *italica.* Iowa: Ames, June 20, 1892, L. H. Pammel (as on *"P. fastigiata"*). Oregon: Portland, June 16, 1931, J. R. Hansbrough (Herb. J. R. H. 610). Vermont: Duxbury, July 18, 1929, P. Spaulding (Herb. P. S. 66776). British Columbia: Revelstoke, Sept. 7, 1930, J. R. Hansbrough (Herb. J. R. H. 610). Quebec: Sillery, May 8, 1936, R. Pomerleau. Germany: Brandenburg, Späthsche Baumschulen zu Rixdorf b. Berlin, July 24, 1903, H. and P. Sydow (Myc. Germ. 30).

P. petrowskyana. Iowa: Ames, June 20, 1892, F. C. Stewart.

P. rasomowskyana. Germany: Dahlem b. Berlin, July, 1902, P. Hennings (Rehm, Ascomyceten 273b).

The occurrence of a stalk cell in *Taphrina populina* was first reported by Frank (1880) and later by Johanson (1887). The existence of a stalk cell was denied by Sadebeck (1890), but as pointed out by Johanson, Sadebeck had confused this fungus with *Taphrina rhizophora.* Sadebeck later (1893) distinguished two types of asci in *T. populina:* (1) Slender, deeply inserted asci, 80-112μ × 20-27μ, provided with stalk cells and occurring on *Populus nigra* L. var. *italica* Dur.; and (2), broad asci, 80μ × 30-40μ, slightly inserted, often lacking stalk cells, occurring on *Populus nigra* L. The fact that the stalk cell may be present or absent has been recorded by most later investigators.

In these studies the two types of asci mentioned by Sadebeck have been found on all but one of the hosts listed above. Asci without stalk cells may have a bluntly rounded or wedge-shaped base, and are less deeply inserted than the longer asci with stalk cells. Neither type of ascus occurs exclusively on any one host. In particular the limits of ascus-size observed for *Populus nigra* are: 30-122μ ×

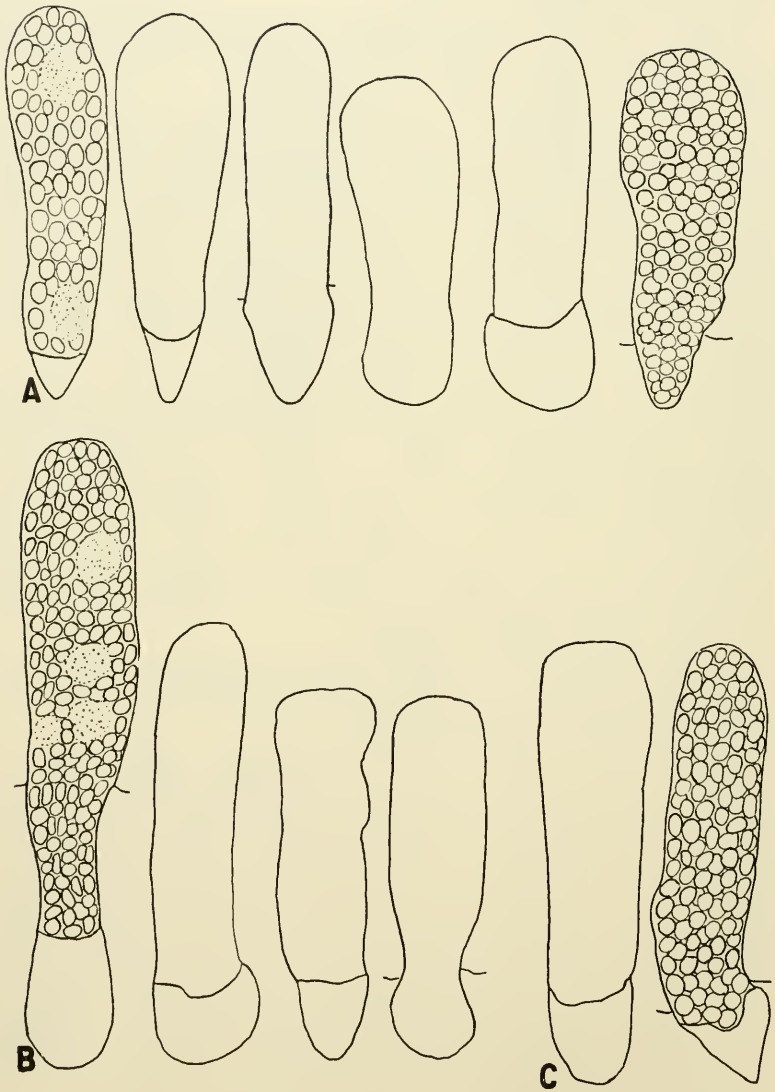

FIG. 8. Asci (×900) of *Taphrina populina*. A, on *Populus nigra;* B, *P. nigra* var. *italica;* C, *P. rasomowskyana.*

16-30μ, and for *P. nigra* var. *italica:* 42-109μ × 15-30μ. (More specimens of the former have been studied.) Asci with stalk cells seem equally common on both hosts. Incidentally no asci as wide as those reported by Sadebeck have been observed.

A further example of the variability of *Taphrina populina* appears in the attempt by Cocconi (1894) to erect a new species, *Exoascus flavo-aureus* for the fungus on *P. nigra* var. *italica*. It possesses, according to his observations, a tapering, rhizoidal ascus-base, inserted between the epidermal cells of the host.

The following is a record of the writer's studies of *Taphrina populina* on the various host-species listed above:

Host	Ascus dimensions in microns	Presence of stalk cell	Stalk cell dimensions in microns
Populus angulata Ait.	33-76 × 20-27	+	10-23 × 10-20
Populus balsamifera L.	63-116 × 17-26	+ or —	8-20 × 10-20
Populus berolinensis Dipp.	43-80 × 17-26	+ or —	8-17 × 10-22
Populus ciliata Wallr.	73-122 × 23-33	+ or —	7-10 × 17-23
Populus generosa Henry	56-76 × 16-20	+ or —	8-10 × 10-13
Populus laurifolia Ledeb.	33-83 × 16-26	+ or —	8-20 × 10-16
Populus nigra L.	30-122 × 15-30	+ or —	5-26 × 10-20
Populus nigra L. var. *italica* Dur.	40-109 × 15-30	+ or —	10-30 × 10-20
Populus petrowskyana Schneid.	43-76 × 13-26	+ or —	10-23 × 13-20
Populus rasomowskyana Schneid.	35-86 × 17-30	+ or —	7-30 × 10-20

Choosing the fungus on *P. nigra* as the type, it might be possible to distinguish varieties, one for each host-species. The danger in this would be that if additional specimens were studied some of the differences evident here might disappear. In the absence of information as to the biological specialization it seems best merely to record that *Taphrina populina* shows marked variability on different hosts.

26. *Taphrina populi-salicis* Mix

Taphrina populi-salicis Mix, Trans. Kansas Acad. Sci. **50**:77-83. 1947.

Causing golden-yellow convex-concave spots on leaves of *Populus fremontii* S. Wats., *P. trichocarpa* Torr. and Gray, and *Salix laevigata* Bebb.

Mycelium intercellular.

Asci hypophyllous, oblong-cylindric, rounded at the apex. Stalk cell invariably present, short and wedge-shaped or long and tapering, often forked, deeply inserted in leaf tissues. Spores (blastospores) numerous, elliptical, ovate, or narrowly elongate. (Fig. 9, A, C, Fig. 10, A, B.)

Dimensions: Of *asci,* 50-106μ × 13-30μ; of *stalk cells,* 7-92μ × 7-27μ; of *spores,* 1.5-5μ × 0.5-4.5μ.

Distribution: Pacific Coast States.

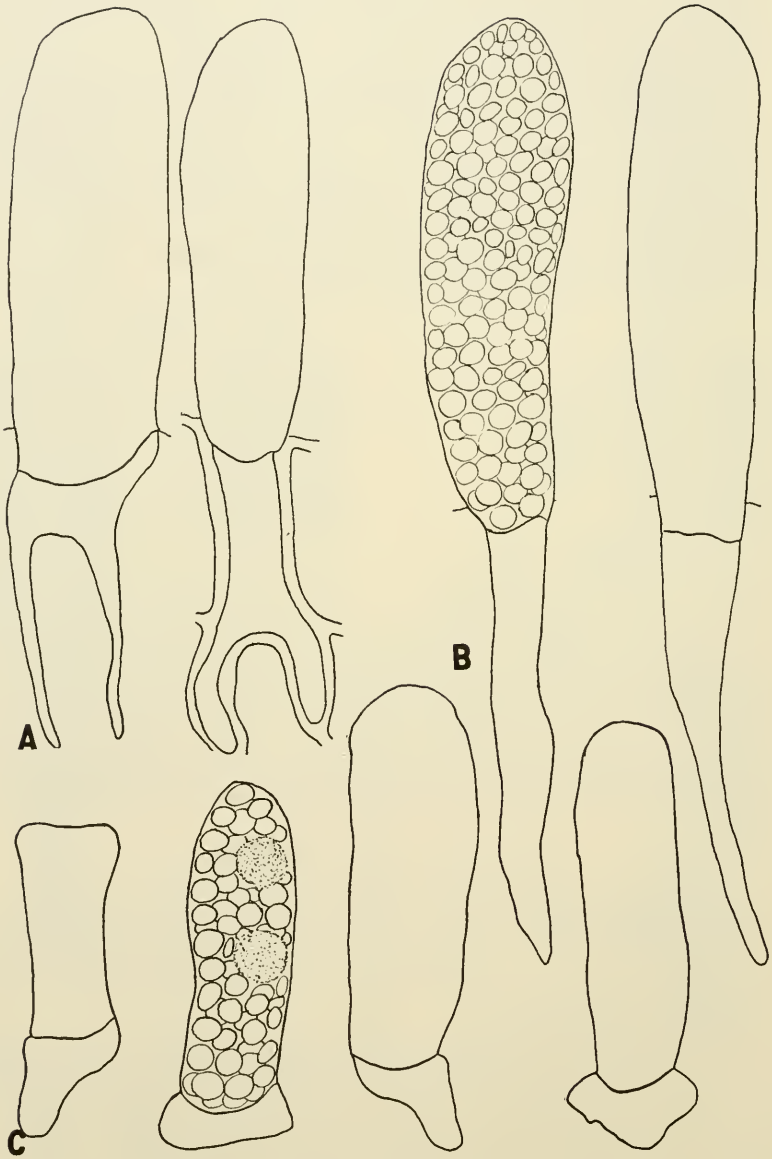

FIG. 9. Asci (× 900) of *Taphrina populi-salicis*. A, on *Populus fremontii;* B, C, *P. trichocarpa.*

Material examined: P. fremontii. California: Berkeley, July 10, 1938, H. N. Hansen; Palo Alto, San Francisquito Creek, May 13, 1941, R. H. Thompson; Sacramento, June 8, 1924, H. E. Parks and W. S. Fields.

P. trichocarpa. California: Glendale, May, 1897, A. J. McClatchie (Fungi Columb. 1228); Palo Alto, April 17, 1940, R. H. Thompson; Richardson Grove, Aug. 22, 1929, G. D. Darker. Oregon: Lane Co., Eula, June 13, 1920, J. S. Boyce (Herb. J. S. B. 594); Portland, Aug. 12, 1931, J. R. Hansbrough (Herb. J. R. H. 609). British Columbia: New Westminster, July, 1938, Malcolm Wilson; Owl Creek, June 24, 1931, J. R. Hansbrough and T. S. Buchanan (Herb. J. R. H. 608).

Salix laevigata. California: Lassen Co., Mineral, Sept. 10, 1911, E. P. Meinecke (Herb. J. S. B. 282).

This fungus, while causing leafspots quite like those caused by *Taphrina populina* shows definite morphological differences, and an apparent biologic distinction, from that species. Boyce (1927) reports observing in the Pacific northwest that *Populus nigra* often is not attacked in the same locality in which *P. trichocarpa* is affected, and that in a nursery in Scotland, in 1925, *Taphrina populina* attacked *Populus generosa, P. laurifolia,* and *P. nigra* (the last named being the most heavily infested), while *P. trichocarpa* growing with its leaves intermingling with those of the diseased *P. generosa* remained healthy.

It is of interest that indigenous west coast species of *Taphrina* described by Mix (1939) and Ray (1939) are different from related forms found in the eastern United States. (*Taphrina populina* was undoubtedly introduced into this region along with its host.)

27. *Taphrina johansonii* Sadebeck

Taphrina johansonii Sadebeck, Jahrb. Hamburg. Wissensch. Anst. **8**:61-95. 1890.
Taphrina rhizophora Johanson, Bih. t.k. Svensk Akad. Handl. **13**:3-28. 1887, in part.
Exoascus johansonii Sadebeck, Jahrb. Hamburg. Wissensch. Anst. **10**:5-110. 1893.
Exoascus aureus auct.

Causing golden-yellow enlargements of carpels of *Populus canescens* Reichenb., *P. grandidentata* Wats., *P. sieboldii* Miq., *P. tremula* L., *P. tremula* var. *pendula* Loud., *P. tremuloides* Michx.

Mycelium intercellular.

Asci elongate, clavate, rounded at apex, with no stalk cell but with a tapering base deeply inserted between host cells; when young with

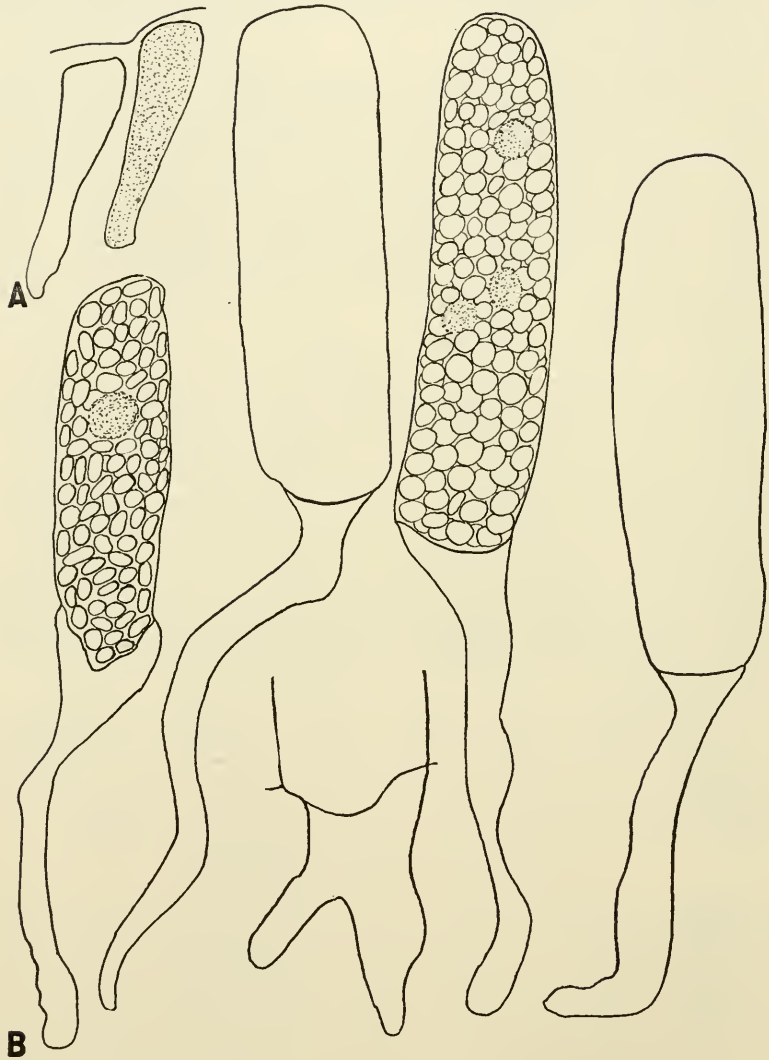

FIG. 10. *Taphrina populi-salicis.* A, ascogenous cells on *Populus trichocarpa;* B, asci on *Salix laevigata.* × 900.

yellow oily contents, yellow oil globules persisting after spore formation; ascospores rarely seen, budding at once to fill the ascus with numerous blastospores which are variable in form: oval, fusiform, or rod-shaped. (Fig. 11, A-E.)

Dimensions: Of *asci,* 60-145μ × 12-27μ, narrowing at the foot to a width of 3 to 10μ, inserted for about one-third (occasionally one-half) the ascus-length; of *ascospores,* 4-7μ × 4-6μ; of *blastospores,* 4-10μ × 1.5-4μ.

Distribution: Europe, eastern North America, Japan.

Material examined: P. canescens. Russia: Moscow, O. L. Park, June, 1893, P. Sydow (Myc. March. 3820).

P. grandidentata. Massachusetts: Peabody, April 19, 1938, D. H. Linder.

P. sieboldii. Japan: Morioka, Kaminoyai, May 24, 1908 (Herb. Morioka Imp. Coll. Agric. and For.).

P. tremula. Denmark: Jylland, Viborg, May 28, 1890, C. A. Gad (Fungi Scand., Gunnar V. Schotte); Firesö, Sj. Koningaarden, May 6, 1894, F. Kølpin Ravn. Finland: Helsingfors, May, 1903, J. I. Liro (Vestergren, Micr. Rar. Sel. 1619).

P. tremula var. *pendula.* Sweden: Stockholm, Hortus Bergianus, June 7, 1924, T. Vestergren.

P. tremuloides. Massachusetts: Medford, April 25, 1891, A. B. Seymour and Agnes W. Lincoln (Seymour and Earle, Econ. F. 191 as *T. rhizophora*); Wellesley, May 20, 1935, D. H. Linder. Michigan: between Brighton and Whitmore Lake, May 24, 1935, L. E. Wehmeyer; near Mich. Agric. Coll., May, 1892 (N. A. F. 1885, F. Columb, 1312, as *T. rhizophora*). New York: Ithaca, Kline Woods Road, May 22, 1940, A. J. M.; Connecticut Hill, May 28, 1940, P. A. Readio. Wisconsin: Racine, F. L. Stevens (F. Columb. 407, as *T. rhizophora*).

Species on the carpels of *Populus* were not at first distinguished from *Taphrina populina* (*T. aurea*). Thus Farlow (1878) reported *T. aurea* on carpels of *P. grandidentata.* Following the description of *T. rhizophora* on carpels of *P. alba* by Johanson (1887) American authors accepted that name.

Farlow (1888) lists as occurring in North America: *T. rhizophora* on carpels of *P. fremontii, P. grandidentata, "P. pyramidalis,"* and *P. tremuloides.* The record on *P. fremontii* seems to be an error, referring to a collection of *T. populi-salicis* on leaves of that host. *"P. pyramidalis"* is a varietyof *P. alba,* but the writer has been unable to find any record of such a collection made in North America.

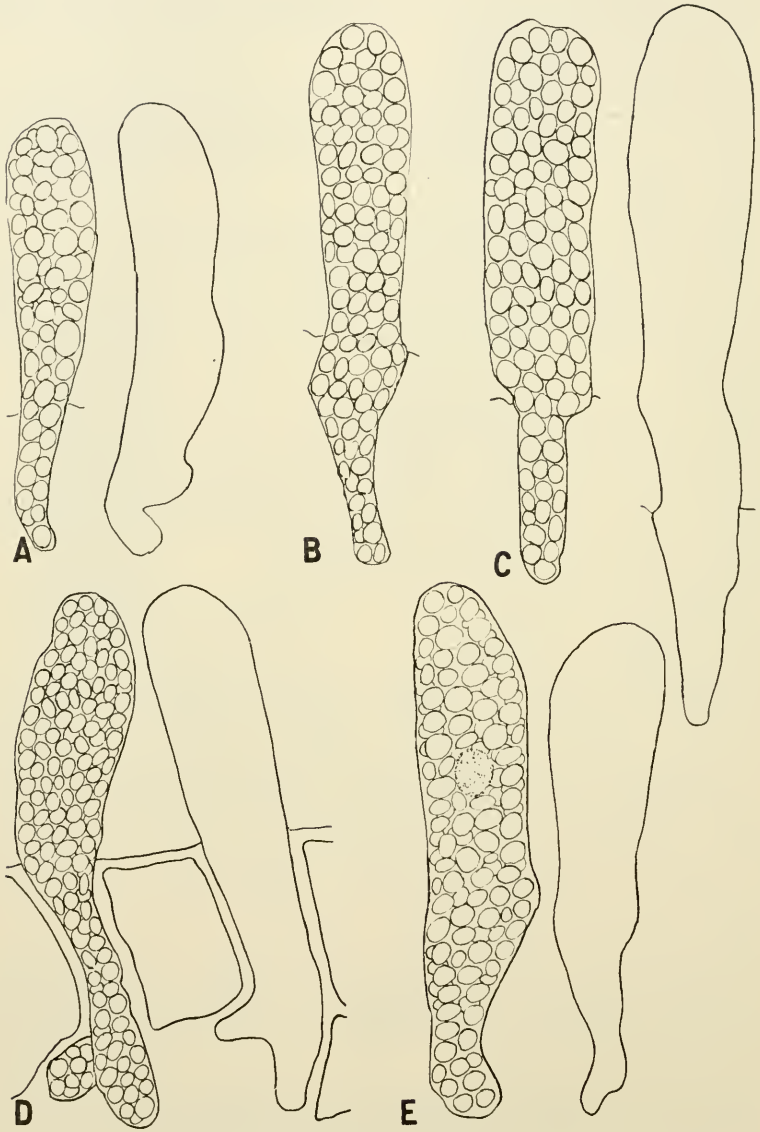

FIG. 11. *Taphrina johansonii.* Asci (× 900), A, on *Populus tremula;* B, *P. canescens;* C, *P. sieboldii;* D, *P. tremuloides;* E, *P. grandidentata.*

Farlow's fungus should have been reported as *Taphrina johansonii*. This was pointed out by Patterson (1895) following the description of *T. johansonii* by Sadebeck (1890). Sadebeck, who earlier (1884) had called this fungus *Exoascus aureus*, described it as having asci 92-105μ long, inserted but never showing rhizoidal forking, it being distinguished by these characters from *T. rhizophora* whose asci were 120-160μ long and often showed rhizoidal extensions of the ascus-base.

The studies reported here, although they extend the limits of ascus-size beyond those reported by Sadebeck, reveal no significant differences between the forms on the various hosts listed above. The ascus-dimensions observed are: For *P. cancscens*, 60-125μ × 17-26μ; for *P. grandidentata*, 66-122μ × 13-23μ; for *P. sieboldii*, 60-120μ × 17-26μ; for *P. tremula*, 60-145μ × 17-27μ; for *P. tremuloides*, 60-125μ × 16-26μ. All these host-forms show asci deeply inserted and possessing a rhizoidal foot, occasionally branched. Clearly they are all *Taphrina johansonii*.

Ikeno (1901) studying a form on *Populus tremula* var. *villosa* Wesm. considered it to be intermediate between *T. johansonii* and *T. rhizophora*, its asci measuring 83-133μ × 20-27μ and penetrating the host for from 17-20μ. He did not observe any rhizoidal extensions and on this basis decided to call it *T. johansonii*. Its dimensions fall within the limits of ascus-size for *T. johansonii* on *P. tremula* as given above.

28. *Taphrina rhizophora* Johanson

Taphrina rhizophora Johanson, Bih. t. K. Svensk. Vetensk. Akad. Handl. **13**:3-28. 1887.
Taphrina aurea auct. in part.
Exoascus aureus auct. in part.
Exoascus rhizophorus (Johans.) Sadebeck, Jahrb. Hamburg. Wissensch. Anst. **10**:5-110. 1893.

Causing golden-yellow enlargements of carpels of *Populus alba* L.

Mycelium intercellular.

Asci long, clavate, rounded at apex, attentuate at the base to a long, rhizoidal, often forking end, deeply inserted (as much as half the ascus-length) between host-cells. Young asci with yellow contents; yellow globules persisting after spore-formation. Ascospores rarely seen, budding at once to form numerous small blastospores, filling the ascus. (Fig. 12, A).

Dimensions: Of *asci*, 76-198μ × 20-30μ, tapering portion 2-10μ in diam.; *ascospores* reported by various authors as round with a diameter of 4μ; *blastospores*, 3.5-5μ × 3-4μ.

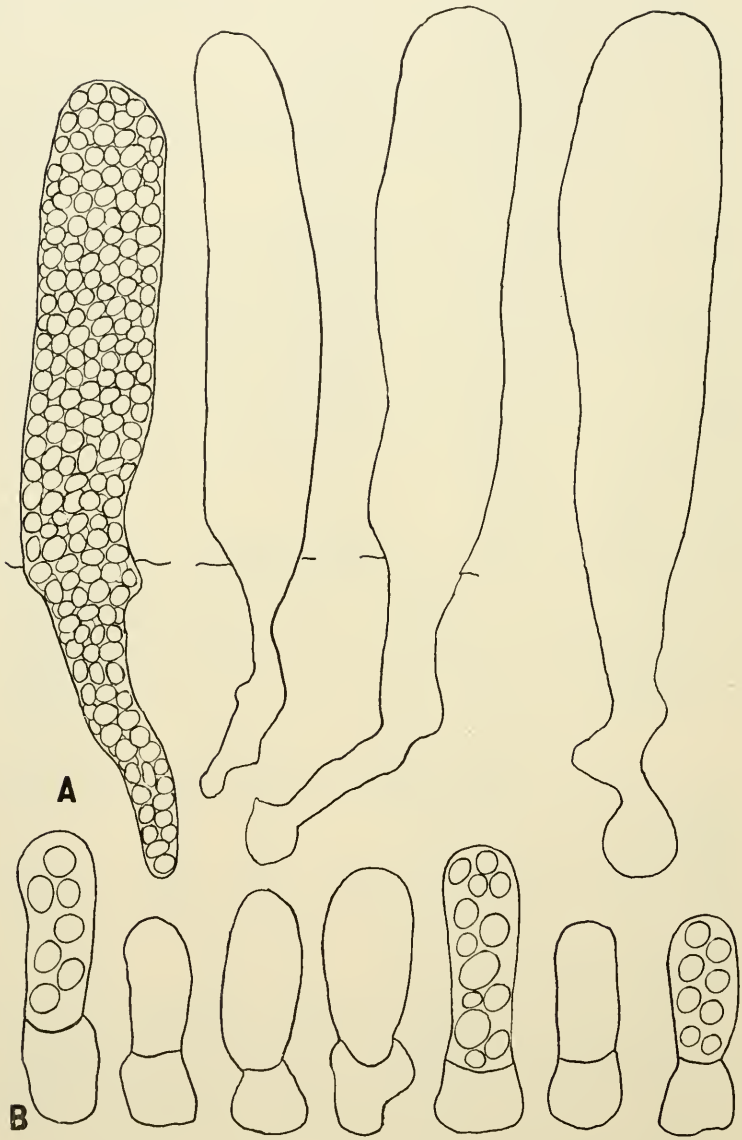

FIG. 12. Asci (× 900) of A, *Taphrina rhizophora;* B, *T. coryli.*

Distribution: Europe.

Material examined: Populus alba. Algier: Teniet-el-Had, April 20, 1930, R. Maire (Herb. R. M., Champ. Afr. d. Nord. 9933, on *P. alba* var *"hickeliana"*). Poland: Pulawy, May 4, 1930, K. Jankowska (Herb. Inst. Phytopath. Schol. Sup. Agric. Warsaw). Sweden: Skåne, Alnarp, May 19, 1890, F. Ulrichsen (Ericksson, F. Par. Scand. 358, as on *Populus* sp. but probably on *P. alba*).

The first mention of a form of *Taphrina* on the carpels of *Populus alba* and of *P. tremula* is by Magnus (1874) who called it *Taphrina aurea.* Sadebeck (1884) considered the fungi on leaves and on carpels of *Populus* to be the same, calling them *Exoascus aureus.* Johanson (1887) described the form occurring on carpels of *Populus alba* and *P. tremula* as a new species, *Taphrina rhizophora.* He gave dimensions of the asci as 80-156μ × 16-22μ, and described the deep insertion of the asci and their long, rhizoidal, often forked, basal extensions. (He suggested that the fungus known in North America on *P. tremuloïdes* was the same.) Sadebeck (1890) in recognizing *T. rhizophora,* separated the form on *P. tremula* as a new species, *Taphrina johansonii.* He gave the ascus-length of *T. rhizophora* as 120-160μ, showing no overlapping with *T. johansonii,* and these measurements have been copied in subsequent literature. Actually there is an overlapping, the writer's measurements (above) showing asci of *T. rhizophora* as short as 76μ.

The writer's stay in Sweden in 1939 was interrupted before a visit to Uppsala could be made, and Johanson's type material has not been studied. This does not seem important since the larger size of the asci on *P. alba* is quite apparent.

Following the principle of disturbing existing situations as little as possible both *T. rhizophora* and *T. johansonii* are here recognized as valid species, though it is not clear that they are well distinguished. Branching rhizoidal extensions of the asci are as common in the one fungus as in the other, and there is an overlapping in ascus-size between the two. Consistent treatment of species on *Populus* would call for uniting these two species into one, or for division of *Taphrina populina* into several species.

The occurrence of *T. rhizophora* on *P. tremula* reported by the writer (1936a) was an error, due to failure to recognize that Sadebeck meant to separate the fungus on *P. tremula* as *T. johansonii.* Jaczewski (1926) reports *T. rhizophora* as occurring on *Populus bachofeni.* This host, according to Index Kewensis, is identical with *P. alba.*

HOST INDEX TO SPECIES OF *TAPHRINA* ON SALICACEAE

Populus alba L.
Taphrina rhizophora Johans.
Populus angulata Ait.
Taphrina populina Fr.
Populus balsamifera L.
Taphrina populina Fr.
Populus berolinensis L.
Taphrina populina Fr.
Populus canescens Reichenb.
Taphrina johansonii Sadeb.
Populus ciliata Wallr.
Taphrina populina Fr.
Populus fremontii S. Wats.
Taphrina populi-salicis Mix
Populus generosa Henry
Taphrina populina Fr.
Populus grandidenta Wats.
Taphrina johansonii Sadeb.
Populus laurifolia Ledeb.
Taphrina populina Fr.
Populus nigra L.
Taphrina populina Fr.
Populus nigra L. var. *italica* Dur.
Taphrina populina Fr.
Populus petrowskyana Schneid.
Taphrina populina Fr.
Populus rasomowskyana Schneid.
Taphrina populina Fr.
Populus sieboldii Miq.
Taphrina johansonii Sadeb.
Populus tremula L.
Taphrina johansonii Sadeb.
Populus tremula L. var. *pendula* Loud.
Taphrina johansonii Sadeb.
Populus tremula L. var. *villosa* Wesm.
Taphrina johansonii Sadeb.
Populus tremuloides Michx.
Taphrina johansonii Sadeb.
Populus trichocarpa Torr. and Gray
Taphrina populi-salicis Mix
Salix laevigata Bebb
Taphrina populi-salicis Mix

III. SPECIES ON BETULACEAE

Corylus, Ostrya, Carpinus, Betula, Alnus

29. *Taphrina coryli* Nishida

Taphrina coryli Nishida, Miyabe Festschrift, Tokyo, 1911, pp. 157-212.

Causing leaf curl involving small spots, large areas, or the whole blade, of *Corylus americana* Marsh., *C. heterophylla* Fisch., *C. rostrata* Ait., and *C. sieboldiana* Blume. Affected areas at first yellowish, becoming white at maturity of asci.

Mycelium intercellular.

Asci amphigenous, cylindric or cylindric-clavate, rounded or truncate at the apex, seated on or slightly inserted in a stalk cell which may be a little broader than the ascus. Ascospores eight, globose, ovate, or elliptic, often budding in the ascus. (Fig. 12, B.)

Dimensions: Of *asci,* 20-40μ × 8-12μ; of *stalk cells,* 10-20μ × 8-17μ; of *spores,* 4-6.5μ × 3.5-6μ.

Distribution: eastern North America, Japan.

Material examined: Corylus americana. Connecticut: Sandy Hook, Botsford Hill, July 4, 1928, A. J. M.; Hammertown Road, between Botsford and Monroe, July 20, 1947, *id.* Massachusetts: Andover, Harold Parker Forest, June 3, 1939, D. H. Linder. Wisconsin: Madison, June 2, 1915, J. J. Davis (F. Columb. 4882); Sparta, June, 1916, J. J. Davis.

C. heterophylla. Japan: Iwate, Terada, June 8, 1907, K. Sawada (Herb. Morioka Imp. Coll. Agric. and For.).

C. rostrata. Connecticut: Westville, summer 1890, R. Thaxter (Rel. Farl. 642).

C. sieboldiana. Japan: Iwate, Mt. Himekawe, June 30, 1907, K. Sawada (Herb. Morioka Imp. Coll. Agric. and For.).

30. *Taphrina ostryae* Massalongo

Taphrina ostryae Massalongo, Bot. Centbl. 34:389-390. 1888.

Causing small, brown, definitely margined, unthickened spots on leaves of *Ostrya carpinifolia* Scop.

Mycelium subcuticular.

Asci hypophyllous, oblong, rounded or obtuse at the apex, seated on a stalk cell which may be somewhat wider than the ascus. Ascospores eight, globose. (Fig. 13, A.)

Dimensions: Of *asci,* 20-24μ × 12-14μ (Massalongo), 17-26μ × 7-10μ (Mix); of *stalk cells,* variable size (Massalongo), 7-10μ × 7-13μ (Mix); of *spores,* 4.5-5μ × 4-4.5μ.

Distribution: Italy.

Material examined: ITALY: Lucca, Vellana, Oct., 1890, G. Tognini (Br. and Cav. F. Par. D. Pl. Colt. od Ut. 169); Verona, valley Tregagno, July, 1898, C. Massalongo (loc. class.).

31. *Taphrina virginica* Sadebeck

Taphrina virginica Sadebeck, Ber. Deutsch. Bot. Ges. **13**:265-280. 1895.

Causing small, pale yellowish thickened areas or leaf curl of the whole blade, on leaves of *Ostrya virginica* Willd.

Mycelium intercellular.

Asci epiphyllous, sometimes hypophyllous, rounded or truncate at the apex, with rounded or truncate, sometimes broadened base, lacking a stalk cell. Ascospores eight, ovate to elliptic, often budding in the ascus. (Fig. 13, B.)

Dimensions: Of *asci,* 20-46μ × 8-13μ, the widened base occasionally measuring 17μ; of *spores,* 4-6.5μ × 4-5μ.

Distribution: eastern North America.

Material examined: KANSAS: Vinland, Baldwin Woods, May 15, 1947, A. J. M.; Lecompton, May 15, 1947, R. L. McGregor. MASSACHUSETTS: Princeton, July, 1888, W. G. Farlow; Wellesley, June 8, 1888, A. B. Seymour (E. F. 497a. Duplicate of type). NEW HAMPSHIRE: Temple, June 16 and 18, 1888, A. B. and A. C. Seymour (E. F. 497b, and 497c). VERMONT: Ferrisburg, Shellhouse Mtn., July 23, 1884, Faxon. WISCONSIN: Potosi, June 7, 1918, J. J. Davis. ONTARIO: Woods east of Holland River, June 3, 1937, H. S. Jackson (Crypt. Herb. Univ. Toronto, 12066).

32. *Taphrina carpini* (Rostr.) Johanson

Taphrina carpini (Rostr.) Johanson, Ofv. Kongl. Svensk. Vetensk. Akad. Forhandl. **1885**:29-47. 1886.
Exoascus carpini Rostrup, Bot. Centbl. **5**:153-154. 1886.

Causing witches' brooms of *Carpinus betulus* L. and *C. orientalis* Mill.

Mycelium subcuticular.

Asci hypophyllous, cylindric, rounded at the apex, truncate and sometimes broadened at the base, lacking a stalk cell; ascospores eight, ovate to elliptic. (Fig. 13, C.)

Dimensions: Of *asci,* 20-30μ × 7-14μ (may broaden at base to 20-24μ); of *spores,* 3.5-5μ × 3-4.5μ.

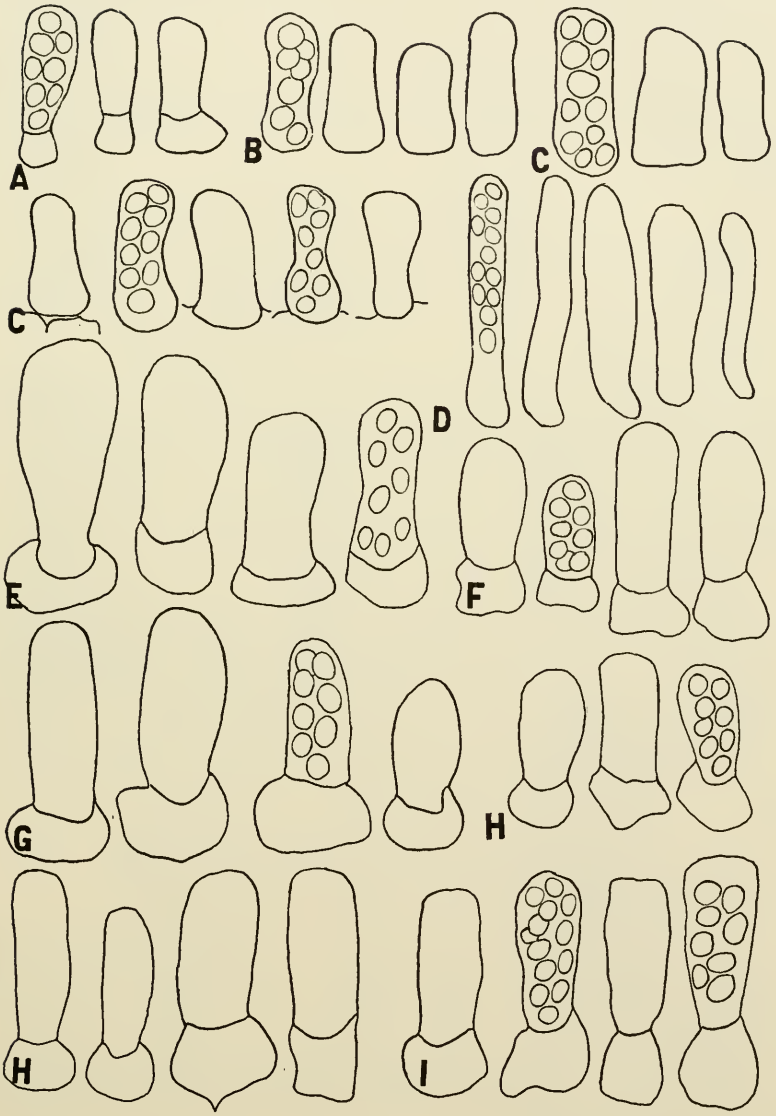

Fig. 13. Asci (× 900) of A, *Taphrina ostryae;* B, *T. virginica;* C, *T. carpini;* D, *T. australis;* E, *T. betulicola;* F-I, *T. americana;* F, G, on *Betula fontinalis;* H, on *B. papyrifera;* I, on *B. lutea.*

Material examined: Carpinus betulus. ENGLAND: Surrey, Virginia Water, July 22, 1935, A. J. M. GERMANY: Thuringia, Steiger near Erfurt, May 29, 1920, H. Diedicke; Escheberg near Bergsdorf, June 20, 1909, O. Jaap (F. Sel. Exs. 408).

C. orientalis. RUSSIA: Kubinski, Ascobaidjan, May 30, 1927; Uljanishtshev (Herb. Inst. Prot. Plants, Sect. Phytopath., Leningrad). SWEDEN: Lund, June 11, 1887, E. Ljungström (Fungi Suecici).

33. *Taphrina australis* (Atk.) Geisenhagen

Taphrina australis (Atk.) Giesenhagen, Flora **81**:267-361. 1895.
Exoascus australis Atkinson, Bull. Torr. Bot. Club **21**:372-380. 1894.

Causing leaf-curl (without evident thickening) of small areas or of the whole blade of leaves of *Carpinus caroliniana* Walt.

Mycelium subcuticular.

Asci epiphyllous, cylindric, truncate or rounded at the apex, narrowed or somewhat broadened at the base, lacking a stalk cell. Ascospores eight, ovate to elliptic. (Fig. 13, D.)

Dimensions: Of *asci,* 20-53μ × 7-12μ (asci as long as 60μ reported by Atkinson); of *spores,* 4-6μ × 2.5-4.5μ.

Distribution: eastern North America.

Material examined: ALABAMA: Auburn, April 30, 1892, G. F. Atkinson (Type? Herb. Dept. Plant Path. Cornell Univ. Atkinson Coll. 2401). CONNECTICUT: North Bloomfield, May, 1919, P. Spaulding (Herb. U. S. D. A. Div. For. Path. 45975).

This species seems to be well distinguished from the preceding by its larger asci and by not forming witches' brooms.

34. *Taphrina betulicola* Nishida

Taphrina betulicola Nishida, Miyabe Festschrift. Tokyo. 1911.

Causing witches' brooms on *Betula ermani* Cham.

Mycelium subcuticular, perennial.

Asci cylindric, rounded or truncate at the apex, provided with a cylindric stalk cell. Ascospores eight, ovate to elliptic, frequently budding in the ascus. (Fig. 13, E.)

Dimensions: Of *asci,* 26-46μ × 13-22μ; of *stalk cells,* 7-13μ × 13-20μ; of *spores,* 3.5μ × 3μ. (Nishida's measurements of stalk cells were: 8-20μ × 20-26μ.)

Distribution: Japan.

Material examined: *Betula ermani.* JAPAN: Nikko, Mt. Shirane, July, 1907, S. Kusano. (Apparently part of type collection. Received from Kusano).

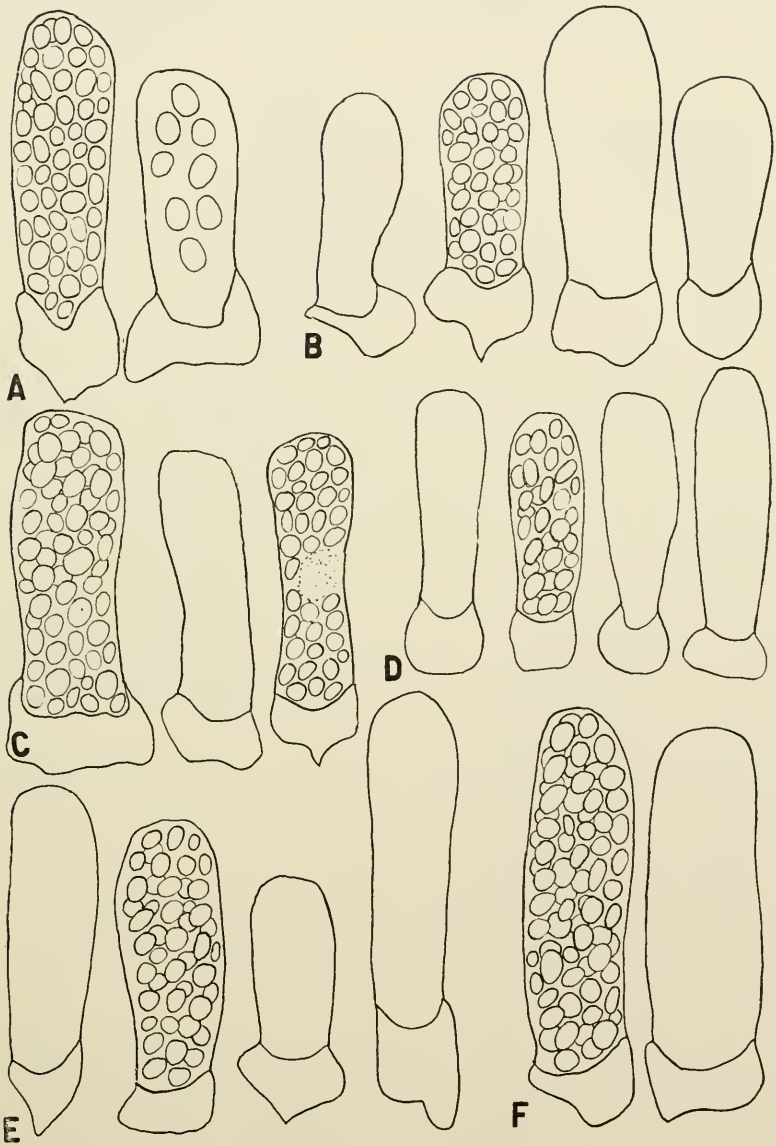

Fig. 14. A-E, asci of *Taphrina betulina*. A, on *Betula carpatica*; B, *B. intermedia*; C, *B. pubescens*; D, *B. pubescens* (as *T. lagerheimii*); E, *B. pubescens* (as *T. lapponica*); F, asci of *T. splendens*. All × 900.

This species is, for the present, held to be distinct from *T. betulina*. Though its ascus-dimensions fall within the size-range of that species, the average size (35 × 16μ) is less, and the stalk cell is shorter.

35. *Taphrina betulina* Rostrup

Taphrina betulina Rostrup, Tidsskr. f. Skovbrug. **6**:199-300. 1883.
Exoascus betulinus (Rostr.) Sadebeck, Jahrb. Hamburg. Wissensch. Anst. **10**:5-110. 1893.
Taphrina lagerheimii Palm, Arkiv. Bot. **15**:1-41. 1917.
Taphrina lapponica Juel, Svensk. Bot. Tidsskr. **6**:353-372. 1912.
Exoascus lapponicus (Juel) Jaczewski, Pocket Key for determination of fungi. Part I. Exoascales, Leningrad, 1926.
Taphrina turgida (Sadeb.) Giesenhagen, Flora **81**:267-361. 1895.
Exoascus turgidus Sadebeck, Jahrb. Hamburg. Wissensch. Anst. **1**:93-124. 1884.
Taphrina willeana Svendsen, Nyt Mag. Vidensk. **40**:363-368. 1902.

Causing witches' brooms. In early stages several or all of the leaves of a shoot may be yellowed (sometimes slightly enlarged but not thickened), but the adventitious twigs of a typical broom may not be present. Subsequently a witches' broom develops. Occurring on: *Betula aurata* Bechst., *B. carpatica* Waldst., *B. intermedia* Thomas, *B. nana* L., *B. pendula* Roth., *B. pubescens* Ehrh.

Mycelium subcuticular, perennial.

Asci cylindric, rounded or truncate at the apex, provided with a stalk cell which may be broad and seated, or wedge shaped and inserted between epidermal cells. Ascopores eight, ovate to elliptic, frequently budding in the ascus, filling it with smaller, ovate or elliptic blastopores. (Fig. 14, A-E, Fig. 15, A, B.)

Dimensions: Of *asci*, 23-73μ × 10-26μ; of *stalk cells*, 7-27μ × 10-30μ; of *ascospores*, 4.5-6.5μ × 4-5.5μ; of *blastospores*, 3.5-6μ × 2-4.5μ.

Distribution: Europe.

Material examined: Betula aurata. GERMANY: Hamburg, Eppendorfer Moor, June 19, 1906, O. Jaap (F. Sel. Exs. 352).

B. carpatica. GERMANY: Scheibe near Schandau, June, 1909, W. Krieger (F. Sax. 2054).

B. intermedia. NORWAY: Gran Hadeland, top of Mt. Framstadsaeterfjeld, June 18, 1901, N. Wille (type of *T. willeana* Svends., received from I. Jørstad). SWEDEN: Jämtland, Storlien, Aug. 24, 1939, A. J. M. (two collections); Lappland, Abisko, Aug. 17-21, 1939, A. J. M. (ten collections); Pålnoviken, Aug. 20, 1939, A. J. M.; Kaskajaure, July 15, 1938, Th. Arwidsson (as *T. lapponica*).

B. nana. NORWAY: Finnmark, Bossekop in Alta, July 29, 1924, I. Jørstad.

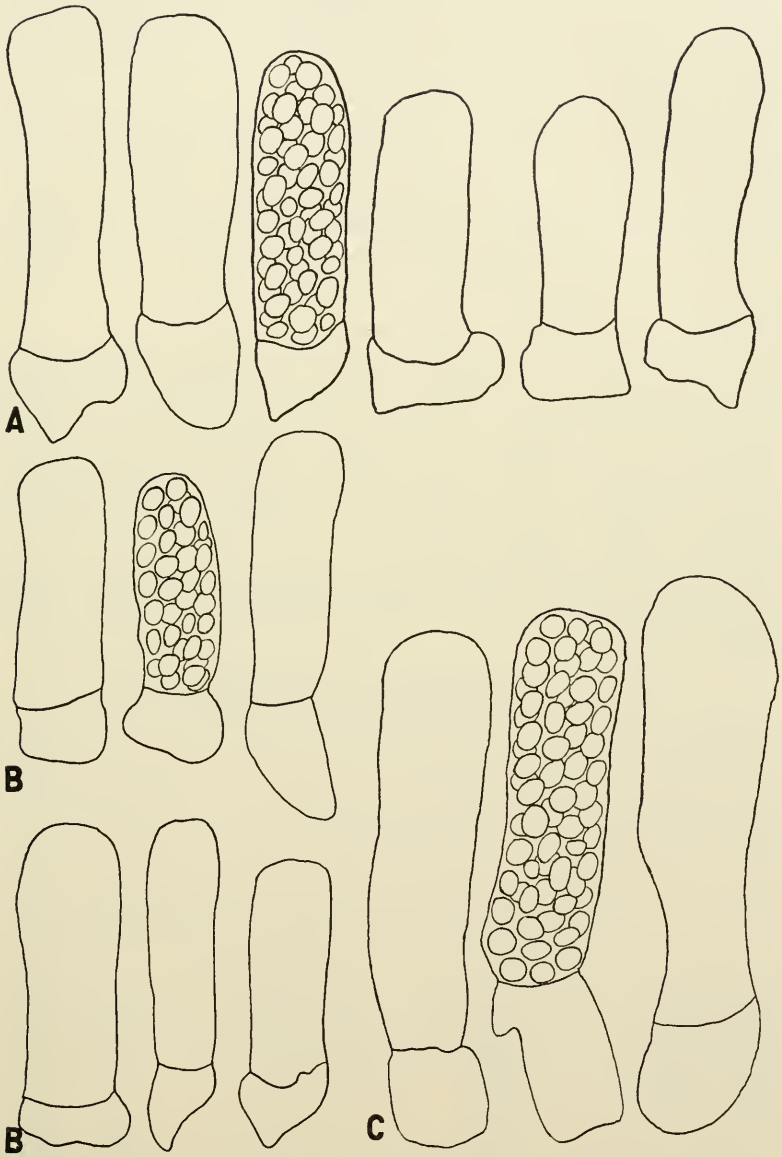

FIG. 15. A, B, asci of *Taphrina betulina;* A, on *B. pendula* (*T. turgida*); B, *B. intermedia* (*T. willeana*); C, asci of *T. splendens* on *B. pubescens.* All × 900.

B. pendula (as *T. turgida*). GERMANY: Brandenburg, Bredower Forest near Nauen, June, 1904, H. Sydow (Myc. Germ. 249). SWEDEN: Grisslehamn, July 13, 1912, O. Juel; Stockholm, Haga, June 12, 1910, B. Palm, Norra Djurgården, June 30, 1939, A. J. M.; Tungelsta, July 13, 1939, A. J. M.

B. pubescens. GERMANY: Westphalia, Hauberg near Siegen, May 22, 1920, H. Ludwig (Myc. Germ. 1646). IRELAND: County Wicklow, Killadreenan House, June 23, 1935, A. J. M. SWEDEN: Jämtland, July 13, 1931, A. G. Eliasson; Storlien, Skurdalshöjden, July 15, 1936, T. Arwidsson; Storlien, Aug. 24, 1939, A. J. M. (two collections); Kälarna, B. Palm; Quikjokk, 1887, G. Lagerheim (Roum. F. G. 4561).

B. pubescens (as *T. lapponica*). NORWAY: Troms, Kirkenesmoen in Målselv, July 31, 1926, I. Jørstad. SWEDEN: Härjedalen, Fjällnäs, Malmagsvålen, June 28, 1933, A. G. Eliasson; *ibid.*, July 2, 1933, A. G. E.; Jämtland, Frostviken, Jorniklumpen, July 2, 1934, J. A. Nannfeldt (F. Exs. Suec. 651); Lappland, Björkliden, July 19, 1911, O. Juel (type); Abisko, July, 1907, T. Vestergren (Micr. Rar. Sel. 1620. *"Vidit auctor"*).

B. pubescens (as *T. lagerheimii*). SWEDEN: Lappland, Abisko, Vaggejokk, Vilkisorta, Björkliden, Pålnoviken, B. Palm (several undated collections).

Synonymy: a. Taphrina turgida (Sadeb.) Gies.

Rostrup (1883) described *Taphrina betulina* from "birch" without giving the specific name of the host, though later (1890) he stated that it was *Betula odorata* (*B. pubescens*). Sadebeck (1884) described *Exoascus turgidus*, also from "birch," and gave *Taphrina betulina* as a synonym. Later Sadebeck (1893) reported the host for *T. turgida* as *B. verrucosa* (*B. pendula*), and stated that *T. betulina* occurred on *B. pubescens*. Sadebeck's distinction between the two species was based on the form of the stalk cell, *T. betulina* having a broad stalk cell, truncate or rounded at the base, seated on the epidermis, while *T. turgida* had a wedge shaped stalk cell, pointed below, and inserted between the epidermal cells. (He also stated that the two species differed in the manner of formation of their ascogenous cells.)

Rostrup (1890) expressed the opinion that *Taphrina betulina* and *T. turgida* were identical, but later (1896) he agreed with Sadebeck's distinction between the stalk cells of the two forms. He also suggested a biological distinction, since he had observed *Betula*

pubescens and *B. pendula* growing close together, with only the former showing witches' brooms.

Actually there is no morphological distinction between the fungus on *Betula pubescens* and the one on *B. pendula*, either in size and shape of asci or in form of stalk cells. In all specimens examined from the hosts named above, both the broad, flat type of stalk cell, and the wedge-shaped, inserted one have been seen. Sadebeck himself (1893) stated that the stalk cells of *T. turgida* were very variable, and that it would be difficult to tell the two species apart by means of this character.

b. Taphrina lapponica Juel.

Juel (l. c.) in distinguishing *T. lapponica* from *T. betulina* stated that the former did not form witches' brooms though invading "whole shoots." According to his account all of the leaves on a branch became yellowed and sometimes enlarged, but adventitious buds were not formed. In the summer of 1939, during a stay in Lappland and Jämtland, the writer become convinced that the above-described appearance is that of a young stage of a witches' broom, resulting from infections of the current year or of a recent year. Stages intermediate between "whole-shoot infection" and witches' brooms were common.

Juel did not find any marked difference in ascus-size between the two species, but reported ascus-dimensions for *T. lapponica* as 40μ × 16μ, the dimensions for *T. betulina* being 45-55μ × 15-20μ. He did, however, assign a shorter host list, finding *T. lapponica* to occur on *Betula intermedia* and on *B. pubescens*.

That the two forms cannot be distinguished morphologically may be seen from the following tabulation made mostly from specimens collected by the writer in Sweden in 1939.

Taphrina lapponica, not forming witches' brooms.

Ascus-size in microns	Stalk cell-size in microns	Collection No.	Host
45-50 × 17-23	8-10 × 17-23	T691	*B. intermedia*
30-50 × 13-20	8-13 × 17-26	T670	*B. intermedia*
40-73 × 17-20	8-17 × 20-23	T672	*B. intermedia*
23-50 × 13-20	8-10 × 20-26	T673	*B. intermedia*
30-50 × 13-17	7-17 × 13-26	T676	*B. intermedia*
33-66 × 13-18	10-13 × 17-20	T677	*B. intermedia*
36-50 × 13-20	7-13 × 17-26	T678	*B. intermedia*
36-50 × 13-20	7-10 × 17-23	T680	*B. intermedia*
36-60 × 17-20	7-10 × 17-23	T681	*B. intermedia*
33-66 × 13-20	7-10 × 17-23	T683	*B. intermedia*
30-46 × 12-20	7- 8 × 13-23	T685	*B. intermedia*
26-43 × 17-20	7-13 × 17-20	T687	*B. intermedia*
33-50 × 13-20	7-13 × 17-20	T766	*B. intermedia*

Ascus-size in microns	Stalk cell-size in microns	Collection No.	Host
40-60 × 13-20	8-10 × 17-20	T690	*B. pubescens*
33-53 × 13-20	7-17 × 13-20	T692	*B. pubescens*
46-56 × 15-26	10-23 × 17-30	T643	*B. pubescens*
50-60 × 15-26	10-17 × 17-26	T635	*B. pubescens*
43-56 × 13-15	8-10 × 17-20	T620	*B. pubescens*
33-40 × 15-23	8-10 × 20-27	T619	*B. pubescens*
33-50 × 12-17	10-13 × 17-23	T618	*B. pubescens*
33-46 × 13-20	8-10 × 17-23	T480	*B. pubescens*
36-50 × 12-18	8-17 × 13-23	T335	*B. pubescens*

T. betulina, forming typical witches' brooms.

Ascus-size in microns	Stalk cell-size in microns	Collection No.	Host
40-53 × 13-20	8-17 × 17-23	T566	*B. aurata*
40-63 × 13-23	8-13 × 17-23	T567	*B. carpatica*
30-53 × 13-20	8-13 × 20-26	T668	*B. intermedia*
30-50 × 13-20	8-13 × 17-23	T671	*B. intermedia*
34-46 × 15-21	6-15 × 15-23	T80	*B. pubescens*
43-63 × 10-17	8-23 × 13-20	T565	*B. pubescens*
33-50 × 10-20	8-13 × 13-23	T649	*B. pubescens*
43-56 × 17-26	13-23 × 10-26	T656	*B. pubescens*
36-46 × 13-23	10-27 × 13-27	T168	*B. pubescens*

This would give as dimensions for *T. lapponica: Asci,* 23-73μ × 12-23μ.; *stalk cells,* 7-33μ × 13-27μ.; for *T. betulina: Asci,* 30-63μ × 10-26μ.; *stalk cells,* 7-27μ × 10-27μ.

The writer's collections of *T. lapponica* on *B. intermedia* and *B. pubescens* were made from trees bearing typical witches' brooms of *T. betulina* as well as from adjacent trees showing only "shoot-infections." This was in the exact locality in which Juel had collected his fungus. It was apparent that the *lapponica*-infections, which included cases where one or a few leaves of a shoot were diseased, were juvenile stages of witches' brooms. A witches' broom being a perennial structure, and only identifiable as a witches' broom after adventitious buds have developed twigs, it could only become established through such juvenile stages. One or more leaves must become infected, mycelium invade the whole shoot, and the formation and development of adventitious buds be induced. In localities such as Lappland, where infestation is great and where infection seems to occur every year, juvenile stages are abundant.

Complete proof of this idea of the formation of a witches' broom could be furnished by inoculation-experiments, which have not yet been possible.

c. Taphrina lagerheimii Palm

This fungus was described by Palm as affecting its host (*B. pubescens*) in the same manner as *T. lapponica* but having *asci,* 53-60μ × 13-5-17μ.; and *stalk cells,* 19.5-23.5μ × 19.5-5-26μ.

Palm preserved no type specimens of his various new species of *Taphrina*. The specimens (listed above) studied by the writer were found by Dr. Th. Arwidsson among Lagerheim's collections in Stockholm's Högskola. They had been collected by Palm and evidently studied by him but bore no date. No collections from Kapellskär in Uppland was found, that being Palm's type locality for *T. lagerheimii*.

Study of these specimens showed dimensions to be: *Asci*, 33-60μ × 10-18μ; *stalk cells*, 10-17μ × 23μ. The stalk cells seen were shorter and narrower than those reported by Palm but even his dimensions fall within the limits for *T. betulina* (including *T. lapponica* and *T. turgida*): *Asci*, 23-73μ × 10-26μ; *stalk cells*, 7-27μ × 10-27μ. Clearly *T. lagerheimii* can not be distinguished from *T. lapponica* and it must become synonymous with *T. betulina*.

d. Taphrina willeana Svendsen

This fungus, described by Svendsen as affecting leaves (wholly or in part) but not discoloring or thickening them, and not forming witches' brooms, is obviously like *T. lapponica*. Svendsen reported its dimensions as: *Asci*, 40-50μ × 15-20μ; *stalk cells*, 20-24μ × 24-30μ. Dimensions obtained by the writer from a study of Svendsen's type-specimen are: *Asci*, 33-56μ × 13-17μ; *stalk cells*, 10-24μ × 13-24μ. These dimensions do not distinguish *Taphrina willeana* from *T. betulina* nor from Juel's *T. lapponica*, nor has it any other distinguishing feature. It must be included in *Taphrina betulina*.

Lind (1913) reports the collection by Rostrup of *Taphrina betulina* on *Betula pubescens* Ehrh. var. *urticifolia* (Loud.) Schelle, and on *B. nigra* L. These specimens have not been seen by the writer.

36. *Taphrina splendens* Palm

Taphrina splendens Palm, Arkiv. Bot. **15**:1-41. 1917.

Affecting leaves of *Betula pubescens* Ehrh. Leaves (in specimens seen) deeper green than normal above, rusty tan beneath, not thickened or enlarged. Apparently not forming witches' brooms.

Mycelium subcuticular.

Asci hypophyllous, cylindric, rounded at the apex; stalk cell rounded or truncate below, of nearly the same width as the ascus. Ascospores, eight, ovate to elliptic, frequently budding in the ascus. (Fig. 14, F, Fig. 15, C.)

Dimensions: Of *asci*, 50-96μ × 13-23μ; of *stalk cells*, 10-33μ × 10-26μ; of *spores*, 4-6.5μ × 3-5.5μ.

Distribution: Northern Norway, Swedish Lappland.

Material examined: NORWAY: Nordland, Bjellådalen in Nord Rana, Juy 21, 1926, I. Jørstad. SWEDEN: Lappland, Abisko, B. Palm (presumably the type, though not so designated); Luleå, July 12, 1926, J. Vleugel.

Some doubt is felt whether to regard this fungus as a separate species or to consider it a northern variant of *Taphrina betulina*. It is possible that it may, on further study, be found to cause witches' brooms. Its asci are definitely larger than those of *T. betulina*.

The longest asci observed in Palm's specimen measured 80μ. Longer asci (96μ) were found in Jørstad's collection. If *Taphrina splendens* is to be recognized as a separate species it should include all northern forms with large asci.

37. *Taphrina nana* Johanson

Taphrina nana Johanson, Ofvers. of K. Svensk. Vetensk. Akad. Forhandl. **1885**:29-47. 1886.
Exoascus nanus (Johans.) Sadebeck, Jahrb. Hamburg. Wissensch. Anst. **10**:5-110. 1893.
Taphrina alpina Johanson, Bih. K. Svensk. Vetensk. Akad. Handl. **13**:3-28. 1887.
Exoascus alpinus (Johans.) Sadebeck, Jahrb. Hamburg. Wissensch. Anst. **10**:5-110. 1893.

Causing yellowing of leaves, without enlargement or thickening, affecting part or all of a shoot, or inducing definite witches' brooms on *Betula ermani* Cham., *B. intermedia* Thom., *B. japonica* Sieb., *B. nana* L., *B. pendula* Roth., *B. pubescens* Ehrh.

Mycelium intercellular (subcuticular in early stages).

Asci at first hypophyllous, later amphigenous, cylindric, rounded or truncate at the apex, with a broad stalk cell seated on the epidermis or with a narrower, wedge-shaped stalk cell inserted between epidermal cells. Ascospores eight, round, ovate or elliptic, often budding in the ascus. (Fig. 16, A-C.)

Dimensions: Of *asci*, 13-30μ × 8-15μ; of *stalk cells*, 7-16μ × 8-20μ; of *ascospores*, 3.5-6μ × 3.5-5μ.

Distribution: Sweden, Germany, Russia, Kamchatka.

Material examined: B. nana. NORWAY: Sør Trøndelag, Knutshø in Opdal, July, 1887, A. Blytt. SWEDEN: Jämtland, Areskutan, July 12, 1884, C. J. Johanson (F. Par. Scand. Exs. 231b. Labelled "*T. carnea*" but apparently duplicate of type); *ibid.*, July 16, 1885, C. J. Johanson (Herb. Bot. Mus. Stockholm 3649); between Hallen and Bydalen, Aug. 3, 1909, O. Juel; Härjedalen, Glän, G. Lager-

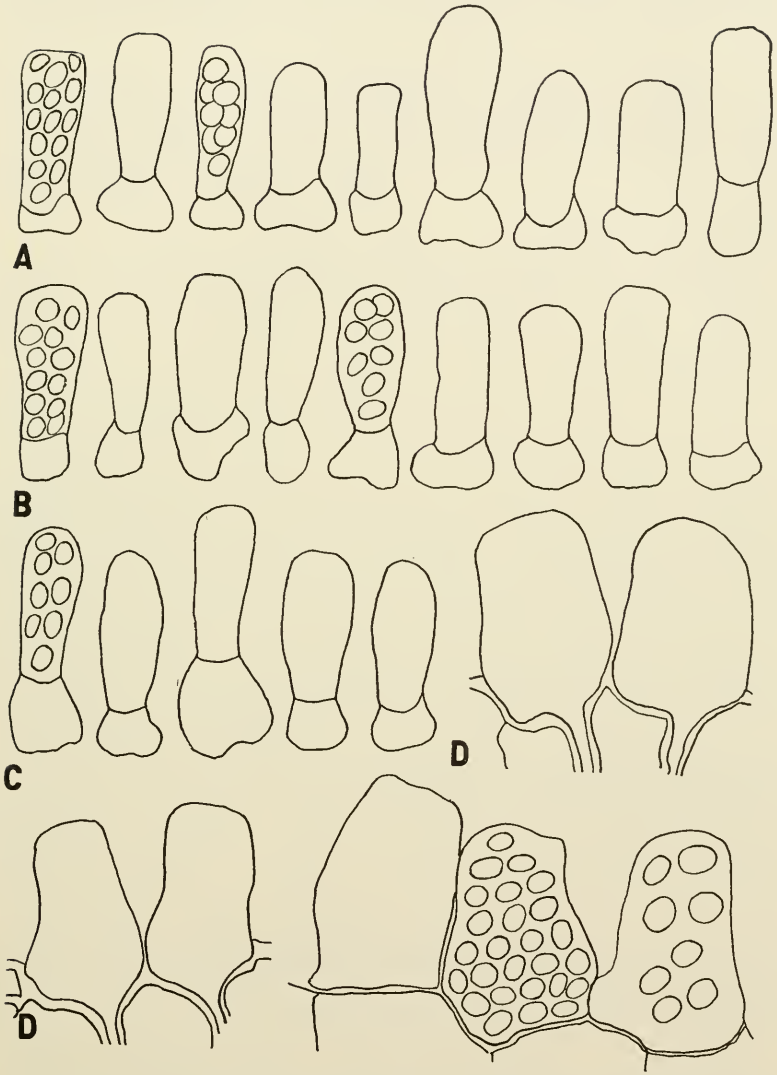

Fig. 16. A-C, asci of *Taphrina nana*. A, on *Betula nana;* B, on *B. nana* (as *T. alpina*); C, on *B. pubescens*. D, asci of *Taphrina boycei* on *Betula fontinalis*. All × 900.

heim; Lappland, Abisko, July 28, 1911, O. Juel (three collections, two labelled "*T. alpina*" the other "*T. nana* var. *hyperborea*" Juel); *ibid.*, B. Palm; *ibid.*, Aug. 18-21, 1939, A. J. M. (four collections, three identifiable as *T. alpina*, one as *T. nana*).

B. pendula. GERMANY: Westphalia, vicinity of Siegen, May-June, 1920, A. Ludwig (Myc. Germ. 1649, as *T. turgida*). POLAND: Anin, July, 1938, H. Juraskowna (Herb. Inst. Phytopath. Schol. Sup. Agric. Varsaviensis, as *T. turgida*). SWEDEN: Falun, July 6, 1904 (as *T. alpina*).

B. pubescens. SWEDEN: Lappland, Abisko, B. Palm.

The distinction between *Taphrina nana* and *T. alpina*, made by Johanson (1887) and concurred in by Juel (1909) was that *T. nana* forms intercellular mycelium throughout the leaf parenchyma, while *T. alpina* has subcuticular mycelium. The occurrence of intermediate forms makes this distinction untenable. Specimens identified by Johanson and by Juel as *T. alpina* show subcuticular mycelium, but modification of one or two rows of the spongy parenchyma as well as of the epidermis occurs. The asci in these specimens are hypophyllous. A specimen collected by Juel in Jämtland, Aug. 3, 1909, and identified by him as *T. nana*, and a specimen collected at Abisko by the writer Aug. 19, 1939, show modification of the lower half of the spongy parenchyma, a little intercellular mycelium, and hypophyllous asci intermediate in size (asci 17-26μ × 8-10μ, stalk cells 7-10μ × 8-13) between those of *T. alpina* and *T. nana* (Johanson's measurements). In most specimens of *T. nana* the mycelium extends throughout the leaf, all the leaf tissues are modified, and the asci are amphigenous, being slightly larger when occurring on the upper surface of the leaf. The asci of *Taphrina alpina* are described by Johanson as 20-27μ × 9-14μ, with stalk cells 8-14 (18)μ × 12-20μ; the asci of *T. nana* being 18-30μ × 7-9μ, stalk cells 7-15μ × 7-17μ. Actually there is no size-distinction between the two forms, though the hypophyllous asci (of either form) are somewhat smaller than the epiphyllous asci.

It is evident that *Taphrina alpina* is merely a juvenile stage of *Taphrina nana*. Infection apparently occurs through the lower epidermis, the spongy parenchyma is first invaded and larger asci form on the upper epidermis. Since the two species are indubitably synonymous the name *Taphrina nana* Johanson has priority. It is interesting that in *Taphrina nana* as in *T. betulina* early stages can be found in which one or all of the leaves of a shoot are attacked but no witches' brooms have yet been formed.

The occurrence in Kamchatka of *T. alpina* on *Betula ermani,* and of *T. nana* on *B. japonica* are reported by Jaczewski (1926). Specimens were not obtainable.

38. *Taphrina americana* Mix

Taphrina americana Mix, Trans. Kansas Acad. Sci. **50**:77-83. 1947.

Causing witches' brooms on *Betula fontinalis* Sarg., *B. lutea* Michx., and *B. papyrifera* Marsh.

Mycelium subcuticular, perennial.

Asci hypophyllous, cylindric, rounded or truncate at the apex; stalk cell broader than the ascus, short and rounded, truncate at the base; ascospores eight, often budding in the ascus. (Fig. 13, G-J.)

Dimensions: Of *asci,* 17-40μ × 8-18μ; of *stalk cells,* 6-20μ × 7-23μ; of *spores,* 4-6μ × 3.5-5.5μ.

Distribution: North America (occasional).

Material examined: B. fontinalis. Colorado: Larimer Co., tributaries South Fork Cache Le Poudre River, Happy Hollow, July 2, 1896, L. H. Pammel (Herb. Iowa Agric. Coll. Plants N. Colo. 118); Boulder Canyon, El Vado, July 27, 1942, A. J. M. (Type).

B. lutea. New Hampshire: Mt. Washington, Alpine Garden, R. Thaxter (Type).

B. papyrifera. New Hampshire: Mt. Washington, Alpine Garden, July, 1886, R. Thaxter (Type). Wisconsin: Solon Springs, July 20, 1914, J. J. Davis.

This fungus is considered distinct from both *Taphrina betulina* and *T. nana* because it is intermediate in ascus-size between these two fungi. It further differs from them in host range and geograpic distribution.

39. *Taphrina boycei* Mix

Taphrina boycei Mix, Amer. Jour. Bot. **26**:44-48. 1939.

Causing small unthickened spots, pale yellow on both sides (resembling those caused by *T. flava*) on leaves of *Betula fontinalis* Sarg., and *B. occidentalis*[6] Hook.

Mycelium intercellular.

Asci hypophyllous, oblong to broad-cylindric, rounded at the apex, often broadened at the base, arising directly from intercellular mycelium, containing persistent pale yellow oil globules; ascospores eight, round, ovate or elliptic. (Fig. 16, D.)

6. Rehder assigns this species in part to *Betula fontinalis* Sarg. and in part to *B. papyrifera* Marsh. var. *occidentalis* (Hook) Sarg. Perhaps the form in question belongs to the latter.

Dimensions: Of *asci,* on *B. fontinalis,* 30-60μ × 20-36μ, on *B. occidentalis,* 30-46μ × 20-33μ; of *ascospores,* 4-5μ × 3.5-4μ.

Distribution: British Columbia.

Material examined: B. fontinalis. BRITISH COLUMBIA: near Cheekye, July 19, 1931, J. S. Boyce and J. L. Mielke (Herb. J. S. B. 1938. Type).

B. occidentalis. BRITISH COLUMBIA: New Westminster, Green Timbers Forest Nursery, July, 1938, Malcolm Wilson; Revelstoke, Big Bend Highway, June 30, 1931, J. S. Boyce and J. L. Mielke (Herb. J. S. B. 1963. Type).

40. *Taphrina carnea* Johanson

Taphrina carnea Johanson, Ofvers. of K. Svensk. Vetensk. Akad. Forhandl. 1885:29-47. 1886.
Exoascus carneus (Johans.) Sadebeck, Jahrb. Hamburg. Wissensch. Anst. 10:5-110. 1893.
Taphrina janus (Thomas) Giesenhagen, Bot. Zeit. 59:115-142. 1901.
Exoascus janus Thomas, Forstl. Naturw. Zeitschr. 6:305-314. 1897.
Taphrina lata Palm, Arkiv. Bot. 15:1-41. 1917.

Causing thickened, yellowish to red, leaf-curl lesions on leaves of *Betula fruticosa* Pall., *B. glandulosa* Michx., *B. humilis* Schrank., *B. intermedia* Thom., *B. lutea* Michx., *B. nana* L., *B. papyrifera* Marsh., *B. pendula* Roth., *B. pubescens* Ehrh.

Mycelium intercellular.

Asci epiphyllous, hypophyllous or amphigenous, broad-cylindric or oblong, sometimes irregular in outline, rounded or truncate at the apex, frequently broadened toward the base, sometimes compressed at the base by adjacent asci, lacking a stalk cell. Ascospores rarely seen, asci commonly filled with blastospores which may be small and ovate to elliptic, or minute and bacterioidal. (Fig. 17, A-C, F.)

Dimensions: Of *asci,* 30-86μ × 10-26μ; widening at base to as much as 30μ; of *ascospores,* 5-6μ × 3-4.5μ; of *blastospores,* 3-6μ × 2-4μ, or if bacterioidal, 1-6μ × 1-1.5μ.

Distribution: Switzerland, Sweden, Russia, eastern North America.

Material examined: B. glandulosa. NEW HAMPSHIRE: Mt. Washington, Lake of the Clouds, July 3, 1886. [Identified by Patterson (1985) as *T. bacteriosperma.*] NEW YORK: Mt. Marcy, July, 1895, C. H. Peck. [Identified by Peck (1896) as *T. bacteriosperma.*]

B. humilis. POLAND: Janow near Lwow, May 30, 1910, M. Raciborski (Myc. Polon. 51).

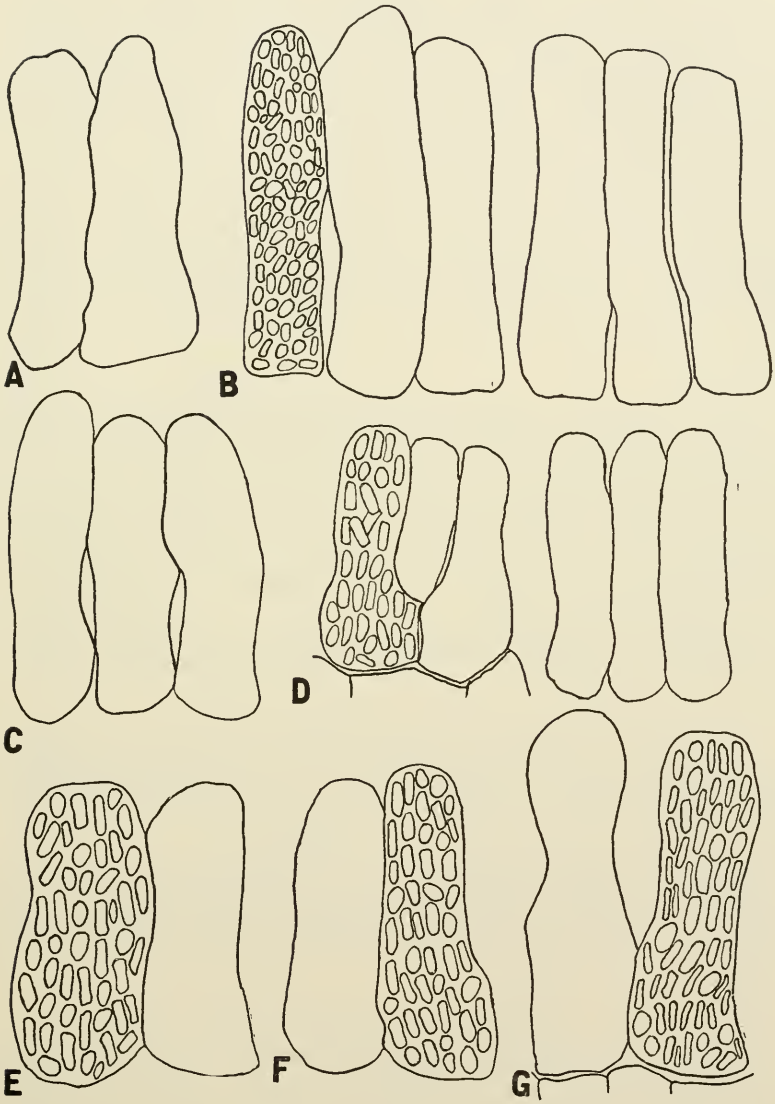

Fig. 17. Asci (× 900) of: A, *Taphrina carnea* on *Betula lutea;* B, *B. pubescens;* C, *B. nana;* D, *T. bacteriosperma* on *B. pubescens* (as *T. janus*); E, *B. pubescens;* F, *T. carnea* on *B. glandulosa;* G, *T. bacteriosperma* on *B. nana.*

B. intermedia. NORWAY: Finnmark, Skådevarre in Alta, July 30, 1924, I. Jørstad; Troms, Alterdet in Kvaenangen, July, 1900, C. J. Svendsen. SWEDEN: Härjedalen, Fjällnäs, June 23, 1933, A. G. Eliasson; Jämtland, Åreskutan, July 20, 1892, Juel; Jämtland, Foot of Snashögarna, July 20, 1889, E. H————g; Storlien, Aug. 24, 1939, A. J. M.; Lappland, Vassijaure, Aug., 1903, T. Vestergren (Micr. Rar. Sel. 721b); Pålnoviken, Aug. 20, 1939, A. J. M.

B. lutea. MAINE: Aquossoc, July 24, 1935, H. B. Peirson (U. S. D. A. Div. For. Path. 35289). ONTARIO: Lake Temagami, Metagama Point, June 27, 1929, H. S. Jackson [Univ. Toronto Crypt. Herb. 1045. Identified by Ray (1940) as *T. bacteriosperma*]. QUEBEC: Duchesnay, June 12, 1941, R. Pomerleau; Pontneuf, June 21, 1940, *id.*

B. nana. NORWAY: Opland, Storhang in Sør-Fron, July, 1893, A. Blytt. SWEDEN: Jämtland, Årestukan, July 20, 1884, C. J. Johanson (duplicate of type); Lappland, vicinity of Peskehaure, July 14, 1938, T. Arwidsson.

B. papyrifera. NEW HAMPSHIRE: Chocorua, May 21, 1911, R. Thaxter.

B. papyrifera var. *minor.* NEW HAMPSHIRE: Mt. Washington, July 3, 1939, D. H. Linder.

B. pendula. SWEDEN: Uppland, Ö. Ryd, Aug. 8, 1910, T. Vestergren (as *T. janus*).

B. pubescens. SWEDEN: Södermanland, road between Strängnäs and Lund, July 13, 1912, T. Holmgren and T. Vestergren (M. Rar. Sel. 1618, as *T. janus*); Tungelsta, B. Palm (as *T. lata*); Stockholm, Uggleviken, June 12, 1895, O. Juel (labelled "*Exoascus bacteriospermus* Joh—*janus* Thomas! teste Sadebeck").

Betula sp. NEW HAMPSHIRE: Mt. Washington, Lake of the Clouds, July, 1897, R. Thaxter; *ibid*, July 3, 1939, D. H. Linder, det. D. H. Linder. QUEBEC: Port Harrison, Aug. 6, 1936, N. Polunin, det. D. H. Linder.

Synonymy: a. Taphrina janus

Thomas (1897) although suggesting that *T. bacteriosperma, T. carnea,* and *T. janus* might actually be forms of the same fungus, described *T. janus* as a separate species, distinguishing it from *T. carnea* only by its amphigenous asci.

Actually it is not possible to distinguish *T. carnea* from *T. janus.* They are identical in their effect on the host, in size, shape, and basal compression of asci, and in producing asci upon one or both surfaces of the leaf.

b. Taphrina lata Palm

This fungus was described by Palm (1917) as causing enlargement and moderate thickening of leaves of *B. pubescens,* and affecting only young seedlings a foot or less tall. It was found only at Tungelsta, Sweden, near the railway station. He reported it as having asci 40-45μ × 18-22μ, with a stalk cell measuring 16-20μ × 25-33μ. The material studied by the writer consisted of a large packet among Lagerheim's collections, labelled only "Tungelsta, Palm." It contained a number of small seedling birches, with leaf-lesions corresponding closely to Palm's description. It seems highly probable that this is the material Palm used in describing *Taphrina lata.*

This is, however, typical material of *T. carnea.* The asci (lacking stalk cells) measure 36-60μ × 13-23μ, widening at the base and showing compression, exactly as in *T. carnea.* If this is Palm's fungus it is difficult to understand how he could have described it as having a stalk cell. In sections made by the writer asci with bases inserted and thus overlain by epidermal cells suggested asci with stalk cells. The mycelium is intercellular, not subcuticular as stated by Palm.

The occurrence of *T. carnea* on *B. fruticosa* Pall. (*B. gmelini* Bge.) is reported by Jaczewski (1926).

41. *Taphrina bacteriosperma* Johanson

Taphrina bacteriosperma Johanson, Bih. t. K. Svensk. Vetensk. Akad. Handl. **13**:3-28. 1897.
Exoascus bacteriospermus (Johans.) Sadebeck, Jahrb. Hamburg. Wissensch. Anst. **10**:5-110. 1893.

Causing yellowing of leaves, without thickening but sometimes with lateral enlargement, often affecting all the leaves of a shoot, but not causing witches' brooms, on *Betula glandulosa* Michx., *B. intermedia* Thom., *B. nana* L., *B. pubescens* Ehrh.

Mycelium subcuticular.

Asci epiphyllous, sometimes also hypophyllous, broad-cylindric, sometimes irregular, rounded or truncate at the apex, broadened at the base and often somewhat compressed by adjacent asci, lacking a stalk cell. Ascospores rarely seen, asci filled with minute bacterioidal blastospores (Fig. 17, A-E, G).

Dimensions: Of *asci,* 33-80μ × 14-20μ, widening at the base to 23-30μ; of *ascospores,* 3.6-4.5μ diam. (Johanson); of *blastospores,* 3-6μ × 1-2μ, or bacterioidal, 1-1.8μ × 0.5μ.

Distribution: Norway, Sweden, Greenland, Russia, North America.

Material examined: B. glandulosa. NEW HAMPSHIRE: Mt. Washington, near Lake of the Clouds, July 3, 1939, D. H. Linder, det. D. H. Linder.

B. nana. NORWAY: Dovrefjeld, foot of Mt. Nordra Kunestiö, July 9, 1933, A. G. Eliasson. SWEDEN: Härjedalen, Fjällnäs, July 27, 1933, O. Ostergren; Jämtland, Årestukan, Ulladalen, July 27, 1895, C. J. Johanson (Type).

B. pubescens. SWEDEN: Lappland, Abisko, July 28, 1911, O. Juel.

This species is not to be distinguished by the size of its asci from *Taphrina carnea.* A distinctive feature is the compression of the widened basal part of the ascus, where asci stand close together. Juel (1909) says that the asci are "grown together a little at the base."

Taphrina bacteriosperma causes no thickening of the leaves of its host, but often some lateral enlargement. Modification of leaf tissues is confined to the epidermis and palisade parenchyma; while *T. carnea* causes typical thickened "leaf-curl," with all mesophyll tissues modified. Since such variation in method of attack is possible within a single species (as indicated earlier for *Taphrina nana*) it would be interesting to compare these two fungi further by means of cultural studies and inoculations. Obviously they are closely related.

42. *Taphrina betulae* (Fkl.) Johanson

Taphrina betulae (Fkl.) Johanson, Ofvers. K. Svensk. Vetensk. Akad. Forhandl. **1885**:29-47. 1886.
Exoascus betulae Fuckel, Jahrb. Nassau. Verein. Naturk. **27** and **29**:1-99. 1873 and 1874.
Ascomyces betulae, Magnus, Rab. F. E. 2734.
Taphrina auctumnalis Palm, Arkiv. Bot. **15**:1-41. 1917.
Taphrina betulae (Fkl.) Johans. var. *auctumnalis* Sadebeck, Jahrb. Hamburg. Anst. **10**:5-110. 1893.

Causing small (up to 1 cm. diam.) pale green to yellow (brown in age) unthickened spots on leaves of *Betula intermedia* Thom., *B. medwediewi* Reg., *B. pendula* Roth., and var. *purpurea* Schneid., *B. pubescens* Ehrh., and *B. turkestanica* Litvin. Spots are evident on either surface of the leaf, showing as a pale area on the opposite surface.

Mycelium subcuticular.

Asci epiphyllous, hypophyllous or amphigenous, cylindric, rounded or truncate at the apex, sometimes broadened at the base. Stalk cells seated, broad and flat, broader than the ascus, or nearly isodiametric, not broader than the ascus. Ascospores eight, ovate to elliptic, sometimes budding in the ascus. (Fig. 18, A-E.)

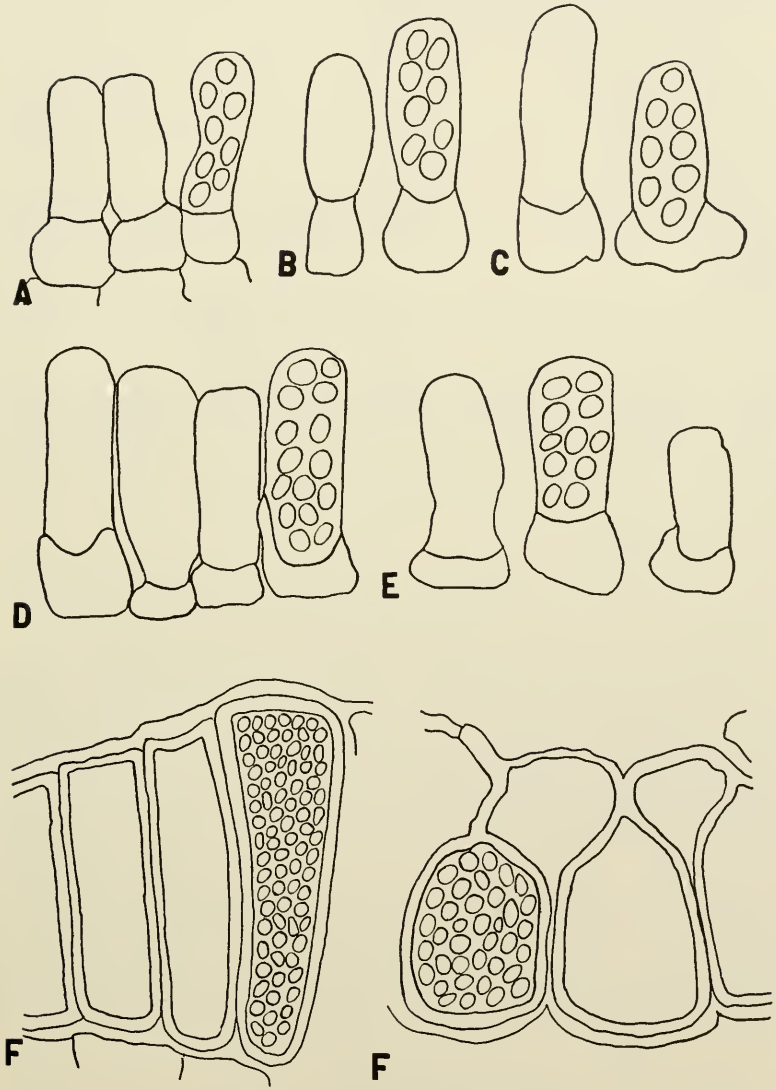

Fig. 18. Asci (× 900) of A-E, *Taphrina betulae*. A, on *Betula pendula;* B, *B. pubescens;* C, *B. intermedia;* D, *B. pubescens* (as *T. auctumnalis*); E, *B. medwediewi;* F, *T. flava* on *B. papyrifera.*

Dimensions: Of *asci*, 17-46μ × 8-18μ; of *stalk cells*, 7-17μ × 8-30μ; of *ascospores*, 4-6μ × 3.5-5μ.

Distribution: northern Europe.

Material examined: B. intermedia. SWEDEN: Lappland, Aug. 21, 1939, A. J. M.

B. medwediewi. RUSSIA: Causasus, Mt. Anczcha, Aug. 16, 1917, W. Siemaszko (Herb. W. S.).

B. pendula. GERMANY: Berlin, Thiergarten, June 12, 1880, P. Magnus (Rab.-Wint. F. E. 2734). SWEDEN: Grisslehamn, Sept. 9, 1912.

B. pendula var. *purpurea.* GERMANY: Berlin, Späth'sche Baumschule, Sept., 1891, P. Sydow (Myc. March. 3358).

B. pubescens. GERMANY: Berlin, Lichterfelde, Oct., 1895 (M. March. 4337, as var. *auctumnalis*); Hamburg, Wandsbek, Sept., 1891, Sadebeck (Munich Herb. Type of var. *auctumnalis*); Ö. Schlesien, Werdenau, June, 1913, J. Horuby (Petrak. Fl. Boh. Mor. Exs. Pilze 776). NORWAY: Bjsokeny, Aug., 1893, G. Lagerheim (as var. *auctumnalis*).

B. turkestanica. GERMANY: Berlin, Späth'sche Baumschule, Sept., 1898, P. Sydow (Myc. March. 3359).

Betula sp. SWEDEN: Sodermanland, Tungelsta, B. Palm.

Sadebeck (1893) described *T. betulae* var. *auctumnalis* on the basis of somewhat smaller asci, 15-27μ × 6-9μ; stalk cells 2-5μ high and very broad, stating that it occurred on *B. pubescens* and rarely on *B. pendula.* Palm in raising this variety to specific rank, confined it entirely to *B. pubescens,* calling the form on *B. pendula T. betulae.* There seems to be no basis for separation of the fungus here studied from *T. betulae* either as a variety or as a separate species, dimensions of asci and stalk cells falling well within those observed for *T. betulae.* Asci as short as 15μ or stalk cells as short as 5μ were not seen in Sadebeck's type material. Presumably, since this is an autumn form, it results from late primary or from secondary infection.

43. *Taphrina flava* Farlow

Taphrina flava Farlow, Proc. Amer. Acad. Arts and Sci. **18**:65-85. 1883.
Magnusiella flava (Farl.) Sadebeck, Jahrb. Hamburg. Wissensch. Anst. **10**:5-110. 1893.

Causing small (up to 5 mm.) yellow to brown or red-brown spots on leaves of *Betula papyrifera* Marsh., and *B. populifolia* Ait.

Mycelium intercellular.

Asci hypophyllous at first, later amphigenous, oblong (on upper epidermis) to squarish (on lower epidermis), arising from the ends of narrow hyphae. Ascospores rarely seen, asci filled with ovate to elliptic blastospores. (Fig. 18, F.)

Dimensions: Of *asci*, 30-63μ × 15-33μ; of *blastospores*, 5-6μ × 5-5.5μ, or minute.

Distribution: eastern North America.

Material examined: B. papyrifera. New Hampshire: Mt. Washington, carriage road, E. Faxon.

B. populifolia. Maine: Kittery Point, July 7, 1929, J. H. Faull (Herb. J. H. F. 9223). Massachusetts: Newton, W. G. Farlow (N. A. F. 300); Roxbury, July 4, 1888, A. B. Seymour (E. F. 171); Waverly, June 17, 1902, A. B. Seymour. New Hampshire: Mt. Washington, head of Great Gulf, July, 1886, W. G. Farlow. Nova Scotia: Lunenberg Co., Chester, July 22, 1929, J. H. Faull (Herb. J. H. F. 9252).

44. *Taphrina robinsoniana* Giesenhagen

Taphrina robinsoniana Giesenhagen, Flora **81**:267-361. 1895.
Exoascus robinsonianus Saccardo and Trotter, Sylloge Fungorum **22**:765.
Taphrina rugosa Ray, Mycologia **31**:56-75. 1939.

Causing protruding tongue-like enlargements of bracts and ovaries of female catkins of *Alnus incana* Moench., and *A. rugosa* Spreng. The tongues appear on the catkins near pollination time and are then very small: 2-3 mm. long. Later in the season when the fruits of the alder are well grown the tongues may measure several millimeters in length. Occasionally also causing leaf curl (involving all or part of the leaf), with typical thickening of leaves, on the same hosts.

Mycelium intercellular.

Asci occurring all over the surface of the tongue, amphigenous on leaves, cylindric, rounded or truncate at the apex, with a stalk cell which may be broader than the ascus and rather long. Ascospores eight, ovate to elliptic, often budding in the ascus, producing numerous ovate to elliptic blastospores. (Fig. 19, A-D.)

Dimensions: Of *asci*, 13-43μ × 6-17μ; of *stalk cells*, 6-20μ × 5-17μ; of *ascospores*, 2.5-6μ × 2.5-5μ.

Distribution: eastern North America.

Material examined: A. incana. Connecticut: Collinsville, Aug., 1926, A. J. M.; East Granby, Dec. 13, 1908, P. Spaulding (U. S. D. A. Div. For. Path. 2028). Maine: Byron, Aug. 25, 1938, A. E.

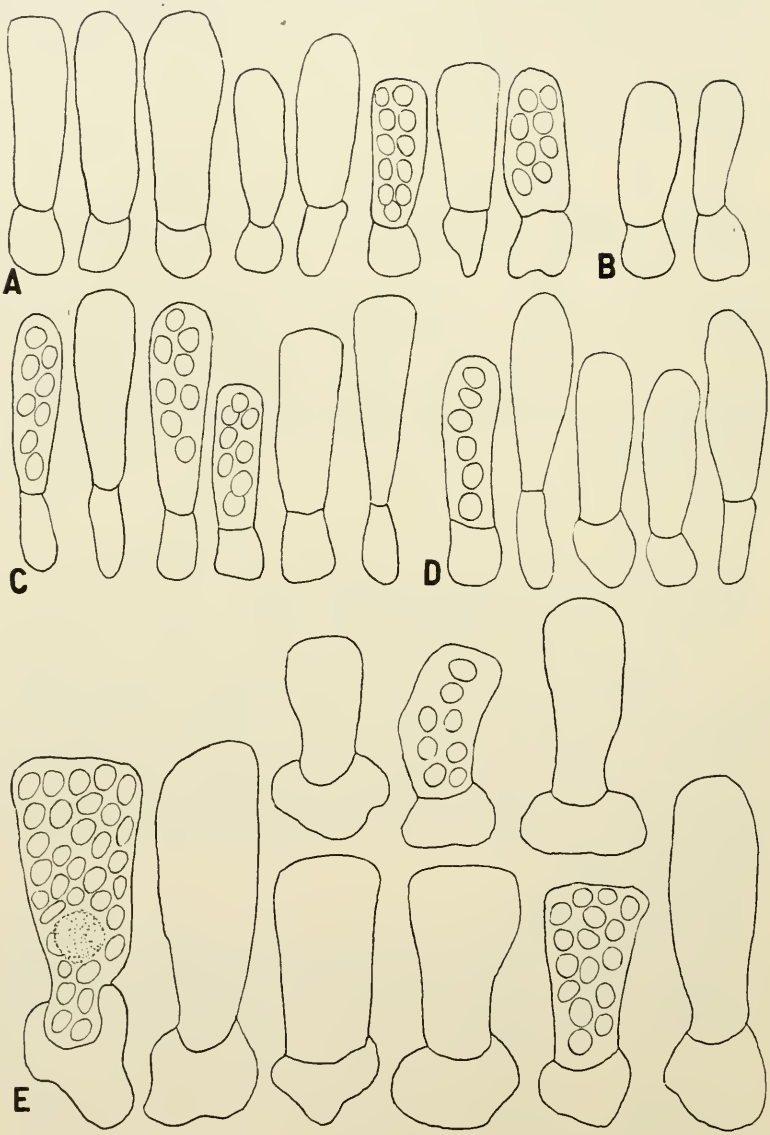

FIG. 19. Asci (× 900) of A, *Taphrina robinsoniana* on *Alnus incana;* B, C, *A. rugosa;* D, the same (*T. rugosa*); E, *T. sadebeckii.*

Prince; Ellsworth, Sept. 14, 1937, J. R. Hansbrough (U. S. D. A. Div. For. Path. 82125); Eustis, July 19, 1935, J. R. Hansbrough (Herb. J. R. H. 2385); Mt. Desert, Bar Harbor, J. S. Boyce (Herb. J. S. B. 2026); Hamden, July 5, 1938, A. E. Prince. Massachusetts: Amherst, Aug., 1934, R. H. Thompson; Granville, Aug. 3, 1885, A. B. Seymour (Econ. F. 167a); Jamaica Plain, Arnold Arboretum, July 28, 1892, A. B. Seymour. Michigan: Copper Harbor, Aug., 1928, A. J. M.; Empire, Aug. 10, 1938, E. A. Bessey. New Hampshire: Carroll, Cherry Mountain, July 27, 1926, P. Spaulding (For. Path. 45312). New York: Blue Mt. Lake, Aug. 24, 1934, G. E. Thompson (Cornell Univ. Dept. Plant Path. Herb. 23806); Ithaca, Ellis Hollow, June 22, 1940, A. J. M.; *ibid.*, July 15, 1940, *id.*; *ibid.*, July 23, 1940, *id.* North Carolina: Old Fort, Oct. 6, 1930, P. Spaulding. Vermont: Bethel, Sept., 1913, P. Spaulding (For. Path. 16833). New Brunswick: Fredericton, July 18, 1936, I. L. Connors (Cent. Expt. Farms Herb. 4518). Newfoundland: Harpoon River, Aug. 18, 1928, P. Spaulding (For. Path. 45640); Spruce Branch, Aug. 23, 1928, P. Spaulding (For. Path. 45649). Nova Scotia: Mahione Bay, Covey Island, July 20, 1936, H. T. Güssow (Cent. Expt. Farms Herb. 4527). Ontario: Lake Temagami, Bear Island, Aug. 10, 1930, I. L. Connors (Cent. Expt. Farms Herb. 1607); Sault Ste. Marie, Sept. 10, 1940, A. J. M. Quebec: Deschambault, I. L. Connors (Cent. Expt. Farms Herb. 1137); Farnham, Aug. 11, 1934, H. N. Racicot (Ottawa Div. Bot. Herb. 3727); Gaspé, Aug. 7, 1894, F. F. Forbes (Phanerogam. Herb. Stanford Univ.).

Alnus rugosa. Alabama: Auburn, April, 1891, G. F. Atkinson (Econ. F. 167b). Arkansas: New Hope, Oct. 15, 1932, D. Demaree (Phanerogam. Herb. Stanford Univ.). Connecticut: Collinsville, Aug. 23, 1937, A. J. M. Georgia: Athens, July 8, 1940; G. E. Thompson; Crawford, Oct. 17, 1935, J. H. Miller (Univ. of Georgia Herb. 2772); Experiment, April 9, 1937, W. A. Jenkins (Cornell Univ. Dept. Plant Path. Herb. 27346. Ray's type of *Taphrina rugosa*); *ibid.*, April 2, 1940, W. A. Jenkins; *ibid.*, April 8, 1940, *id.*; *ibid.*, April 22, 1940, *id.*; *ibid.*, May 2, 1940, *id.*; *ibid.*, May 20, 1940, *id.*; *ibid.*, Aug. 14, 1940, *id.* Massachusetts: Quincy, July, 1939, D. H. Linder (on both catkins and leaves); *ibid.*, Aug. 9, 1940, *id.* New York: Ithaca, June 23, 1940, A. J. M.; *ibid.*, July 12, 1940, *id.*; *ibid.*, Aug. 9, 1940, *id.* Tennessee: Montvale Springs, April 15, 1934, A. J. Sharp and L. R. Hesler (Univ. Tenn. Herb. 6094). Virginia: Fairfax Co., Black Pond, July 12, 1922, A. E. Jenkins.

Alnus sp. MASSACHUSETTS: Manchester, July 17, 1916, W. G. Farlow; Stony Brook, Oct., 1893, E. A. Burt; Wellesley, July 23, 1935, D. H. Linder; Worcester, July, 1924, H. E. Greenwood.

Ray (1939) described as a new species *Taphrina rugosa* on very small catkins of *Alnus rugosa,* using material collected by W. A. Jenkins at Experiment, Georgia. The distinguishing features were the very small, slender tongues, 2 or 3 mm. long, and the small asci (asci, 14-28μ × 4.5-9μ, stalk cells, 8-14μ × 6-10μ) and the small spores (2-4.5μ diam.) which were often 4 or 6 rather than 8 per ascus. Ray stated this to be a southern form, distinct from the common *Taphrina robinsoniana* of the northeast.

Since it seemed possible that *Taphrina rugosa* might be a juvenile stage of *T. robinsoniana,* probably to be found on both *Alnus incana* and *A. rugosa,* special study of the question was undertaken. In examination of Ray's type material no asci were seen so short as those reported by him, the dimensions observed being: Asci, 23-33μ × 8-10μ; stalk cells, 10-17μ × 5-8μ. Shorter asci were, however, observed later in certain other specimens.

Following examination of the type specimens a search was made among various collections for specimens of *Alnus incana* or *A. rugosa* showing very small tongues. The following were found: *A. incana,* Spruce Branch, Newfoundland, Aug. 23, 1928, P. Spaulding, tongues 2-3 mm. long, asci 16-36μ × 8-10μ, stalk cells 6-17μ × 8-13μ; Hamden, Maine, July 5, 1938, A. E. Prince, tongues 2-3 mm. long, asci 17-23μ×8-10μ, stalk cells 7-13μ×5-10μ. *A. rugosa,* Montvale Springs, Tennessee, April 15, 1934, A. J. Sharp and L. R. Hesler, tongues 2-3 mm. long, asci immature, only ascogenous cells being present; Black Pond, Virginia, July 12, 1922, A. E. Jenkins, tongues 5-8 mm. long, asci 20-30μ × 7-10μ, stalk cells 10-17μ × 7-10μ.

During a stay at Cornell University in 1940 the writer received through the kindness of Dr. W. A. Jenkins specimens of *"Taphrina rugosa"* on *Alnus rugosa* collected by him on April 2, April 22, May 2, May 20, July 8, and August 14. In the first two of these collections only a few very short tongues were evident and the fungus was immature. Doctor Jenkins suggested (in a letter of April 9) that the overgrowths were from enlarged ovaries rather than from bracts. This is true of the earliest outgrowths observed but in the material collected April 22 and later, as well as in the specimens discussed above, both ovaries and bracts were enlarged. Contiguous bracts and ovaries may show tongues.

In the collection of April 22 the tongues were 2-3 mm. long, and

a few mature asci were present, measuring 26-33μ × 7-10μ, stalk cells 10-13μ × 8-10μ. In the collection of May 2, the tongues were 5-10 mm. long and 2-3 mm. wide. On tongues from ovaries asci were 13-33μ × 7-10μ, stalk cells 18-17μ × 7-10μ; on those from bracts asci measured 23-40μ × 7-10μ, stalk cells 13-17μ × 7-10μ. In the collection of May 20 the tongues were 1 to 3 cm. long, although the catkins were still very small. Asci measured 26-36μ × 8-10μ, stalk cells 8-20μ × 8-13μ.

It is to be noted that in the earliest collections showing mature asci some of these asci were large enough to be characteristic of *Taphrina robinsoniana*. Ascospores measured 4.5-5μ × 4-4.5μ and were frequently 4 or 6 per ascus rather than 8. In the specimens of May 20, eight-spored asci were more common and some asci contained blastospores.

In the collections of July 8 and August 14 the outgrowths were long (typical of *T. robinsoniana*) and asci measured 26-32μ × 7-9μ; stalk cells 8-13μ × 7-13μ.

Alnus rugosa is rare in the vicinity of Ithaca but a few trees occur in Stewart Park along Cayuga Lake Inlet. These were visited on May 14, 1940, when the male catkins were shedding pollen. A week later pollination was over although styles and stigmas were still evident. There was no sign of fungus attack. Observations were continued at weekly intervals and on June 23, a number of reddish tongues, about 2 mm. long, were seen protruding from some catkins. These catkins were still very small, about "pollination-size," styles and stigmas were still evident, and the catkins were quite like those in the early collections received from Georgia.

Weekly visits to these alders were continued and the gradual enlargement of the outgrowths watched. It became evident that the large "summer" tongues characteristic of *T. robinsoniana* are enlarged states of the very small early outgrowths.

Collections were made on June 23, July 12, and August 9. On July 12 infected leaves were also collected. These collections may be summarized as follows:

June 23, tongues 2 mm. long, asci 20-26μ × 8-10μ, stalk cells 8-10μ × 7-10μ, spores often 6 per ascus, 4.5μ × 4μ.

July 12, tongues 5 mm. long, asci 26-40μ × 8-12μ, stalk cells 8-20μ × 8-12μ, spores often 8 per ascus, 4.5-5μ × 8-12μ, blastospores present.

August 9, tongues 2 cm. long, asci 26-36μ × 8-12μ, stalk cells 10-17μ × 8-12μ, spores mostly blastospores.

On the curled leaves collected July 12, the amphigenous asci measured 17-26μ × 7-10μ, stalk cells 7-10μ × 7-10μ. This is in agreement with observations made on material collected at Quincy, Massachusetts, July, 1939, by D. H. Linder. In these specimens asci from catkins measured 23-40μ × 8-12μ, stalk cells 13-20μ × 7-13μ, asci from leaves 23-26μ × 7-10μ; stalk cells 10-17μ × 7-13μ. Evidently asci formed on leaves are regularly somewhat smaller than those on catkins, a fact already noted for *T. robinsoniana* by Ray (l. c.).

Coincident with these observations of the fungus on *Alnus rugosa,* its development on *A. incana* was watched. Specimens of these alders growing at Ellis Hollow, near Ithaca, were inspected at frequent intervals beginning May 15. Collections were made on June 22, July 15, and July 23. Observations were as follows:

June 22, tongues 1-2 mm. long, asci 20-33μ × 8-10μ, stalk cells 8-17μ × 8-13μ, spores mostly 8 per ascus, 4-6μ × 4-4.5μ.

July 15, tongues 1 cm. long, asci 17-36μ × 8-10μ, stalk cells 8-16μ × 8-13μ, spores 5-6μ × 4.5-5μ, mostly blastospores.

July 23, tongues 1-1.5 cm. long, asci 26-43μ × 10-13μ, stalk cells, 8-17μ × 7-10μ, spores mostly blastospores.

Infected leaves were collected on July 23. On these the asci were somewhat smaller than on the catkins.

From these observations two conclusions are inescapable: that there is no morphological distinction between *Taphrina robinsoniana* on *Alnus incana* and on *Alnus rugosa,* and that *Taphrina rugosa* is a juvenile stage of *T. robinsoniana.*

American collectors have been slow to recognize the identity of *Taphrina robinsoniana* and many collections have been reported as *T. alni-incanae* (Kühn) Magn. [*T. amentorum* (Sadeb.) Rostr.]. Conners (1932) has mentioned this error in identification and has suggested the probability that *Taphrina amentorum* does not occur in eastern North America. Conners' suggestion led to the examination of a very large number of collections (listed above). All specimens proved to be *Taphrina robinsoniana. Taphrina amentorum* on *Alnus rubra* has been reported from Alaska (Ray, 1939).

45. *Taphrina sadebeckii* Johanson

45. *Taphrina sadebeckii* Johanson, Ofv. of K. Svensk. Vetensk. Akad. Forhandl. 1885:29-47. 1886.
Exoascus alni de Bary in Litt., in part.
Exoascus flavus Sadebeck, Jahrb. Hamburg. Wissensch. Anst. 1:93-124. 1884.
Exoascus epiphyllus Sadeb. var. *maculans* Sadebeck, Jahrb. Hamburg. Wissensch. Anst. 8:61-95. 1890.

Ascomyces tosquinetii Westerdorp, Bull. Acad. Roy. Sci. Lett. et Beaux-arts Belgique 2 ser. 11:644-660. 1861, in part.

Causing moderate-sized (up to 1 cm. diam.) yellow spots on leaves of *Alnus glutinosa* Gaertn., *A. hirsuta* Turcz., *A. hirsuta* Turcz. var. *sibirica* Schneid., and *A. rugosa* Spreng.

Mycelium intercellular.

Asci hypophyllous, sometimes also epiphyllous, cylindric, rounded or more often truncate at the apex, often with pale yellowish epiplasm, inserted in a broad stalk cell (often broader than the ascus). Ascospores eight, ovate to elliptic, frequently budding in the ascus. Ascus emerging from the chlamydospore (ascogenous cell) by rupture of the chlamydospore wall. (Fig. 19, E.)

Dimensions: Of *asci,* 17-65μ × 10-21μ; of *stalk cells,* 7-23μ × 13-30μ; of *ascospores,* 4-6μ × 3.5-5μ.

Distribution: Europe, Japan.

Material examined: Alnus glutinosa. Denmark: Jylland, Viborg, June 15, 1903, J. Lind. Germany: Brandenburg, Triglitz, July 20, 1903, O. Jaap (Myc. Ger. 172); Hamburg, Eppendorfer Moor, July, 1930, A. J. M. Ireland: County Wicklow, Killadreenan House, June 22, 1935, A. J. M. Sweden: Stockholm, Lidingö, July 22, 1884, J. Erikson (F. Par. Exs. 226); Rydbo, Aug. 6, 1939, A. J. M.; Statens Växtskydds Anstalt, Aug. 12, 1939, A. J. M.

A. hirsuta. Germany: Berlin, Sept., 1891, P. Sydow (Myc. March. 1360). Japan: Iwate, Mt. Himekami, June 15, 1907, G. Yamada (Herb. Morioka Imp. Coll. Agric. and For., as *T. epiphylla*); Mt. Hayachine, June 13, 1909, *id.* (as *T. epiphylla*).

A. rugosa. Sweden: Stockholm, Bergianska Trädgården, Aug. 10, 1939, A. J. M.; *ibid.,* Aug. 11, *id.*; *ibid.,* Aug. 12, *id.*

Sadebeck reports this fungus on *A. hybrida* A. Br. Three collections so labelled were found in exsiccati: Krieger, F. Sax. 70 (Königstein, Aug.-Sept., 1904, W. Krieger), and Herb. K. Starcs (Riga, Latvia, July 30, 1930, Gulbene, Lithuania, Aug. 30, 1931, K. Starcs). In these collections the host seems to be *Alnus incana,* and the fungus *Taphrina epiphylla.* Occurrence of *T. sadebeckii* in Russia on *A. hirsuta* var. *sibirica* Schneid. is reported by Jaczewski (1926).

Of interest is the occurrence of this fungus in Sweden on the American alder *Alnus rugosa.* The trees observed were heavily infested, indicating that if *Taphrina sadebeckii* were introduced into eastern North America a susceptible host would be waiting.

46. *Taphrina tosquinetii* (Westend.) Tulasne

Taphrina tosquinetii (Westend.) Tulasne, Ann. Sci. Nat. 5 Ser., Bot. **5**:122-136. 1866.
Ascomyces tosquinetii Westendorp, Bull. Acad. Roy. Sci. Lett. and Beaux-arts Belgique. 2 Ser. **11**:644-660. 1861.
Taphrina alnitorqua Tulasne, Ann. Sci. Nat. 5 Ser. Bot. **5**:122-136. 1866, in part.
Exoascus alnitorquus Sadebeck, Jahrb. Hamburg Wissensch. Anst. **1**:93-124. 1884, in part.
Exoascus alni de Bary in litt., in part.
Taphrina media Palm Arkiv. Bot. **15**:1-41. 1917.

Deforming leaves (leaf-curl of part or whole blade) of *Alnus crispa* (Ait.) Pursh. var. *mollis* Fern., *A. glutinosa* Gaertn., and *A. hybrida* A. Br. Affecting whole shoots or shoot-systems, but not forming true witches' brooms.

Mycelium subcuticular, perennial.

Asci amphigenous, cylindric, truncate at apex, stalk cells inserted between epidermal cells. Ascospores eight, often budding in ascus, ovate to elliptic. Ascus emerging from the chlamydospore (ascogeous cell) by rupture of the chlamydospore wall. (Fig. 22, B-D.)

Dimensions: Of *asci*, 17-40μ × 7-13μ; of *stalk cells*, 7-17μ × 8-17μ; of *ascospores*, 2.5-5.5μ × 2.5-5μ.

Distribution: Europe.

Material examined: A. crispa var. *mollis*. NEW HAMPSHIRE: Lyme Center, Holt's Ledge, June 26, 1929, H. H. Whetzel and D. S. Welch (Herb. Cornell Univ. Dept. Plant Path. 17566).

Alnus glutinosa. BELGIUM: Vallée de Munster (Ht. Rhin.), Aug. 25, 1872 (Herb. Inst. Bot. Strasbourg). GERMANY: Brandenburg, between Ruhlsdorf and Marienweder, Aug. 6, 1920, H. and P. Sydow (Myc. Germ. 1648); Hamburg, Eppendorfer Moor, July, 1930, A. J. M.; Thuringia, between Jescha and Berka, near Sondershausen, Sept. 6, 1905, G. Oertel (Myc. Germ. 492). IRELAND: County Wicklow, Killadreenan House, June 23, 1935, A. J. M.; Killarney, June 19, 1935, A. J. M. SWEDEN: Göta Canal near Tröllhattan, Aug. 26, 1935, A. J. M.; Rådmansö, July 9, 1939, A. J. M.; Tungelsta, July 13, 1939, A. J. M.; Virabruk-i-Rosslagskulle, July 18, 1939, A. J. M. (loc. class. for *T. media*).

A. hybrida. GERMANY: Hamburg, Eppendorfer Moor, June 9, 1905, O. Jaap (F. Sel. Exs. 305b).

Palm (1917) described *Taphrina media* as intermediate between *T. tosquinetii* and *T. epiphylla*. Apparently he meant to give dimensions of asci as 25-30μ × 10-12μ, and they are so stated in his key to species, but in his species-description length of asci is given as 25-90μ. Obviously this is a typographical error; it has been pre-

served by later writers. Since Palm left no type specimen of *Taphrina media* and no specimen of any fungus collected by Palm on *Alnus glutinosa* was to be found among Lagerheim's collections, a visit was paid on July 18, 1939 to the type-locality, Virabruk. (This was arranged through the kindness of Dr. T. Arwidsson.)

Virabruk is an abandoned iron foundry, and the alders along the brook running through it are comparatively few, so that a thorough search was easily accomplished. The so called "witches' brooms" pictured by Palm (his figure 4) were easily found, appearing as upturned clusters of twigs at the ends of branches on the larger alders. They were entirely free of any fungus, and whatever their cause, were obviously not due to the action of any species of *Taphrina*. Palm must have collected his fungus from the diseased shoots of the younger alders nearby. These shoots were attacked by *Taphrina tosquinetii*, and this fungus was the only species of *Taphrina* to be found at Virabruk. The collection of *T. tosquinetii* made there showed asci 20-30μ × 8-13μ; stalk cells, 8-17μ × 10-13μ. The asci could be considered intermediate between those of *T. tosquinetii* and those of *T. epiphylla* if the dimensions of those fungi as given in the literature were correct. If the revised dimensions of *T. tosquinetii* (as given above) are considered, the asci clearly belong to that fungus. It must be concluded that Palm was in error in thinking he had a new species and that the fungus he described was *Taphrina tosquinetii*.

The fungus on *Alnus crispa* var. *mollis* was identified by Dr. A. E. Jenkins as *Taphrina media* Palm. A letter from Prof. H. H. Whetzel to Dr. C. L. Shear is enclosed with the specimens in the Cornell Herbarium. This states: "The effect on the plant is that of systemic invasion, a sort of witches' broom, the affected leaves standing up in a staring fashion." This description might apply to the effect of *Taphrina tosquinetii* on *Alnus glutinosa*. The asci of the New Hampshire fungus are shorter than the longest asci observed in *T. tosquinetii*, measuring 16-26μ × 8-13μ; stalk cells 8-13μ × 8-15μ. The ascus emerges from the chlamydospore in the same manner as in *T. tosquinetii*. It seems better to assign this fungus to *Taphrina tosquinetii*, even though that fungus is not heretofore known from North America, than to erect a new species on the basis of this one collection.

47. *Taphrina amentorum* (Sadeb.) Rostrup

Taphrina amentorum (Sadeb.) Rostrup, Vidensk. Meddel. Naturh. Foren. Kjøbenhavn. **1890**:246-264.
Exoascus amentorum Sadebeck, Sitzungsber. Ges. Bot. Hamburg **4**:90. 1888.
Ascomyces alni Berkeley and Broome, Ann. and Mag. Nat. Hist. **17**:129-145. 1876.
Exoascus alnitorquus (Tul.) Sadebeck var. *alni-incanae* J. Kühn. (Fungi Europaei 1616.)
Taphrina alni-incanae (Kühn) Sadebeck, Jahrb. Hamburg Wissensch. Anst. **8**:16-95. 1890.
Exoascus alnitorquus (Tul.) Sadebeck, Jahrb. Hamburg Wissensch. Anst. **1**:93-124. 1884, in part.
Exoascus alni de Bary, in litt., in part.
Exoascus alni de Bary var. *strobilinus* Thümen, Flora **63**:312-322, 323-332. 1880.
Ascomyces tosquinetii Westend. var. *strobilina* Rostrup, Tidskr. f. Skovbrug **4**:113-206. 1880.

Causing rather large (larger than those caused by *T. robinsoniana*) tongue-like outgrowths from the female catkins of *Alnus glutinosa* Gaertn., *A. hirsuta* Turcz., *A. hybrida* A. Br., *A. incana* Moench, and *A. rubra* Bong.

Mycelium intercellular.

Asci cylindric, truncate at apex, lacking a stalk cell, inserted between epidermal cells, Ascospores eight, often budding in the ascus, ovate to elliptic. Asci emerging from the chlamydospore (ascogenous cell) by rupture of the chlamydospore wall. (Fig. 20, A-C.)

Dimensions: Of *asci*, 26-53μ × 10-23μ; of *ascospores*, 4.5-6μ × 4-5μ.

Distribution: Europe, Japan, Alaska.

Material examined: A. glutinosa. GERMANY: Mecklenburg, Warnemünde, Aug. 16, 1904, O. Jaap. (F. Sel. Exs. 78a).

A. hirsuta. JAPAN: Iwate, Gomyojin, Aug. 17, 1907, G. Yamada (Herb. Morioka Imp. Coll. Agric. and For.).

A. hybrida. GERMANY: Mecklenburg, Warnemünde, Aug. 16, 1904, O. Jaap. (F. Sel. Exs. 78b).

A. incana. GERMANY: Bavaria, Lechufer near Fussen, Aug. 18, 1912, H. Sydow (Myc. Ger. 1111); Pomerania, Ruhgenmahdermünde, Sept., 1894, P. Sydow (Herb. Sydow). POLAND: Pieniny, Aug., 1928, W. Siemaszko (Herb. Inst. Phytopath. Schol. Sup. Agric. Varsaviensis).

A. rubra. ALASKA: Lake Pironsi Glacier, B. E. Fernow (Phanerogam Herb. Cornell Univ.).

This fungus has been widely known as *Taphrina alni-incanae* (Kühn) Magnus. As Ray (1939) has pointed out, the first description was by Sadebeck (1888) who called it *Exoascus amentorum.*

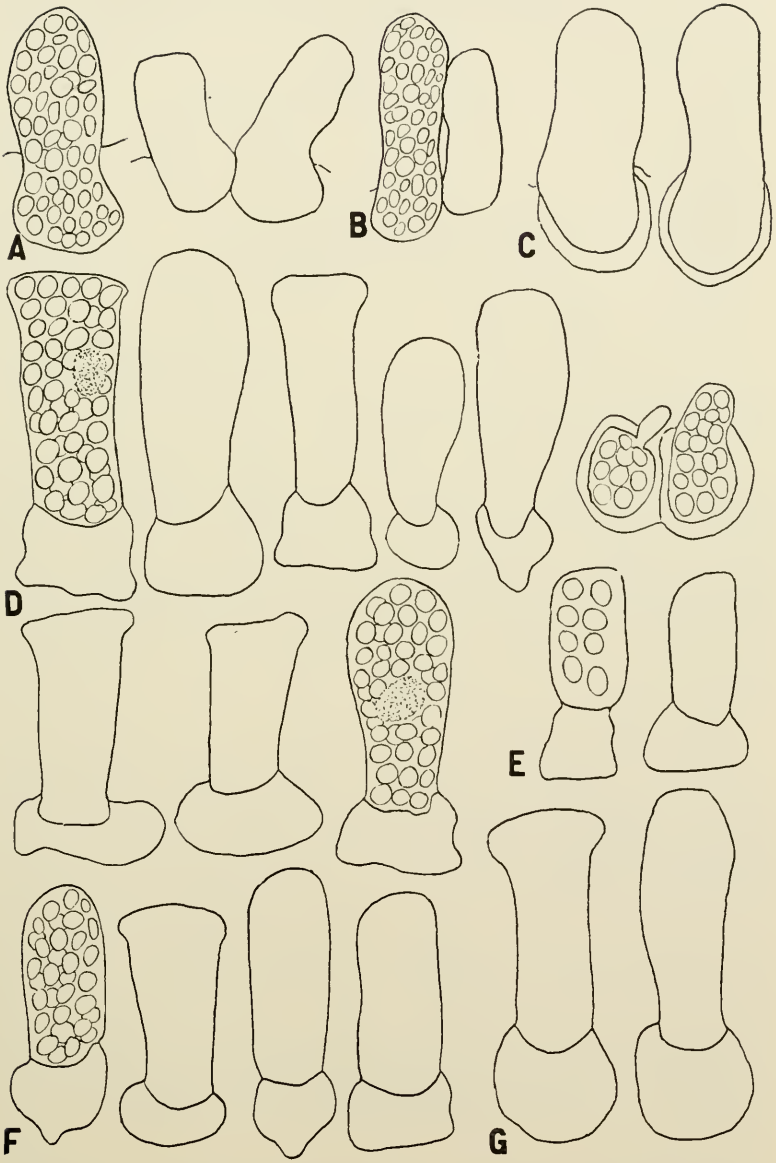

FIG. 20. Asci (× 900) of A, *Taphrina amentorum* on *Alnus glutinosa*; B, *A. incana*; C, *A. hybrida*; D, *T. epiphylla* on *A. incana*; E, *A. incana* f. *aurea*; F, G, *T. epiphylla* (*T. klebahni*).

Rostrup (1890) transferred it to *Taphrina*, it thus becoming *Taphrina amentorum* (Sadeb.) Rostrup. Ray (1939) has been the first to record the occurrence of this fungus on the North American continent.

48. *Taphrina epiphylla* Sadebeck

Taphrina epiphylla Sadebeck, Jahrb. Hamburg Wissensch. Anst. 8:61-95. 1890.
Exoascus epiphyllus Sadebeck, Jahrb. Hamburg Wissensch. Anst. 1:93-124. 1884.
Taphrina sadebeckii Johans. var. *borealis* Johanson, Ofvers. K. Svensk Vetensk. Akad. Forhandl. 1885:29-47. 1886.
Taphrina borealis Johanson, Bih. K. Svensk Vetensk. Akad. Handl. 13:3-28. 1887.
Taphrina klebahni Wieben, Forsch. auf Geb. Pflanzenkr. und Immun. in Pflanzenr. 3:139-176. 1927.

Causing witches' brooms and (in midsummer) yellowish spots on leaves of *Alnus incana* Moench. Leaves not thickened.

Mycelium subcuticular, perennial.

Asci amphigenous, broad-cylindric, usually truncate and often abruptly widened at the apex to a flat head, inserted in a broad stalk cell which may be truncate or pointed below. Ascospores eight, ovate to elliptic, commonly budding in the ascus. Pale yellowish epiplasm present. Asci emerging from the chlamydospore (ascogenous cell) by rupture of the chlamydospore wall. (Fig. 20, D-G.)

Dimensions: Of *asci*, 20-60μ × 10-23μ; of *stalk cells*, 7-20μ × 10-30μ; of *ascospores*, 4-7μ × 4-7μ.

Distribution: Europe.

Material examined: GERMANY: Berlin, Aug., 1891, P. Sydow (Myc. March. 3757, host given as *A. hybrida* but evidently *A. incana*); Hamburg, Eppendorfer Moor, July, 1930, A. J. M. (two collections); Rhine province, Westerwald, Stegskopf, July 30, 1922, A. Ludwig (Mye. Ger. 1956). NORWAY: Orkedalen, July 16, 1887, J. Brunchorst (Herb. Växtskyddsanstalt, Stockholm; host given as *A. glutinosa* but evidently *A. incana*). POLAND: Wilno, June 10, 1928, W.; Konopacka (Herb. Inst. Schol. Sup. Agric. Varsaviensis). SWEDEN: Jämtland, Hålland, July 23, 1915, O. Juel; Lappland, Abisko, Aug. 17, 1939, A. J. M.; *ibid.*, Aug. 21, 1939, *id.*; Stockholm, Bergianska Trädgården, July 3, 1939, A. J. M. (collections on *A. incana*, *A. incana* var. *monstrosa* Winkl., and var. *aurea* Schelle.)

The following were collected as *Taphrina klebahni*: GERMANY: Hamburg, Eppendorfer Moor, July, 1930, A. J. M. (two collections). NORWAY: Ulvik, Aug. 18, 1935, A. J. M. SWEDEN: Stockholm, Ber-

gianska Trädgården, Aug. 10-12, 1939, A. J. M. (collections on *A. incana, A. incana* var. *aurea* and var. *monstrosa*).

Wieben (1927) did not give dimensions of the stalk cells of *Taphrina klebahni,* though from her description of the fungus it is clear that she recognized their occurrence. The collections from Eppendorfer Moor, Hamburg (the type-locality) were made with the assistance of Miss Wieben.

Taphrina klebahni is evidently a late summer form of *T. epiphylla.* The first spots appear after the leaves of the witches' brooms have borne asci and ascospores have been discharged. These spots apparently result from infection by ascospores (or blastospores), and presumably the resulting mycelium may overwinter and cause a new witches' broom.

There is no morphological distinction between *Taphrina epiphylla* and *T. klebahni.* Both have the same curious "tack-headed" asci and the same pale-yellowish epiplasm. In size of asci, stalk cells, and spores they are alike.

Both fungi seem to have the same biologic specialization. In the Hortus Bergianus at Stockholm a plantation of *Alnus* was under observation during the summer of 1939. Specimens of *Alnus incana,* of *A. incana* var. *aurea,* and var. *monstrosa,* and of a variety with pendulous branches, all showed witches' brooms of *T. epiphylla* when observed early in July. In August when most of the leaves had fallen from these witches' brooms, a heavy infestation of *T. klebahni* appeared on the same trees. A specimen of *A. incana* var. *oxycanthoides* Schotte, whose branches intermingled with a tree of *A. incana* var. *aurea* remained free from both fungi, as did a nearby tree of *A. incana* var. *curvatipinnatifida* Wittr. Specimens of *Alnus rugosa* (from North America) were heavily infested by *Taphrina sadebeckii* and specimens of *Alnus cordata* Desf., and *A. viridis* DC showed no signs of fungus attack.

The spots caused by *Taphrina klebahni* are usually small, one-half to 1 cm. in diameter, but in the specimens collected at Ulvik, Norway, all or nearly all of the leaf was involved, and only the absence of witches' brooms differentiated the fungus from typical *Taphrina epiphylla.* Apparently the shoot-system was being attacked by way of the leaves, and witches' brooms might be expected to follow.

Wieben (1927) reported copulation of ascospores (or blastospores) for both *Taphrina epiphylla* and *T. klebahni.* This phenomenon has not been observed to occur regularly in any other species.

49. *Taphrina japonica* Kusano

Taphrina japonica Kusano, Bot. Mag. Tokyo, **19**:1-5. 1905, also Ann. Mycol. **3**:30-31. 1905.
T. alni-japonicae Nishida, Miyabe Fertschrift. Tokyo, 1911.
T. macrophylla Ray, Mycologia **32**:155-158. 1940.

Causing leaf curl with thickening, affecting part or all of the blade, on leaves of *Alnus japonica* Sieb. and Zucc., and *A. rubra* Bong.

Mycelium subcuticular.

Asci amphigenous, broad-cylindric, rounded at the apex, frequently truncate at the base and broadened to a one-sided foot, lacking a stalk cell. Ascospores eight, globose, frequently budding in the ascus, filling it with ovate to elliptic blastospores (Fig. 21, A-C.)

Dimensions: Of *asci,* 33-92μ × 13-33μ, widening at base to 40μ (if considered separately, *T. japonica* 46-92μ × 23-33μ, *T. alni-japonicae* 36-85μ × 17-28μ, *T. macrophylla* 36-86μ × 13-26μ), of *ascospores,* 4-5.5μ×4-5-5.5μ, of *blastospores,* 2-6.5μ×2-5μ.

Distribution: Japan, Pacific coast of North America.

Material examined: Alnus japonica. JAPAN: Fukui, Tsudogama, May 6, 1922, T. Asano; Ichikawa, June 9, 1907, S. Kusano; Iwate, Morioka, June 21, 1904, G. Yamada (as *T. alni-japonicae*); *ibid.,* July 26, 1905, *id.*; Tokyo, Botanic Garden, May 6, 1904, S. Kusano (duplicate of type of *T. japonica*).

A. rubra. ALASKA: June 26, 1923, J. P. Anderson. CALIFORNIA: Humboldt Co., Trinidad, March 24, 1931, H. E. Parks (Herb. Univ. California 3592). OREGON: Tillamook Co., Siuslaw National Forest, Hebo, May 9, 1923, J. S. Boyce (Herb. J. S. B. 1182).

Apparently *Taphrina japonica* Kusano, *T. alni-japonicae* Nishida, and *T. macrophylla* Ray are one and the same fungus, for which the name *T. japonica* has priority. *Taphrina japonica* is said by Kusano to form witches' brooms, but judging from the way this term is employed by many writers his statement may merely mean that whole shoots and shoot-systems are affected. At any rate the curled leaves produced by *T. alni-japonicae* may well be due to infection by a fungus which will later induce a witches' broom or deform a whole shoot (similar situations exist in *Taphrina cerasi* and other witches'-broom formers). The leaves on the Japanese specimens are not so greatly enlarged as in the American specimens of the fungus on *Alnus rubra.* This may either be a host-effect, or a difference that would disappear if more abundant Japanese material were at hand.

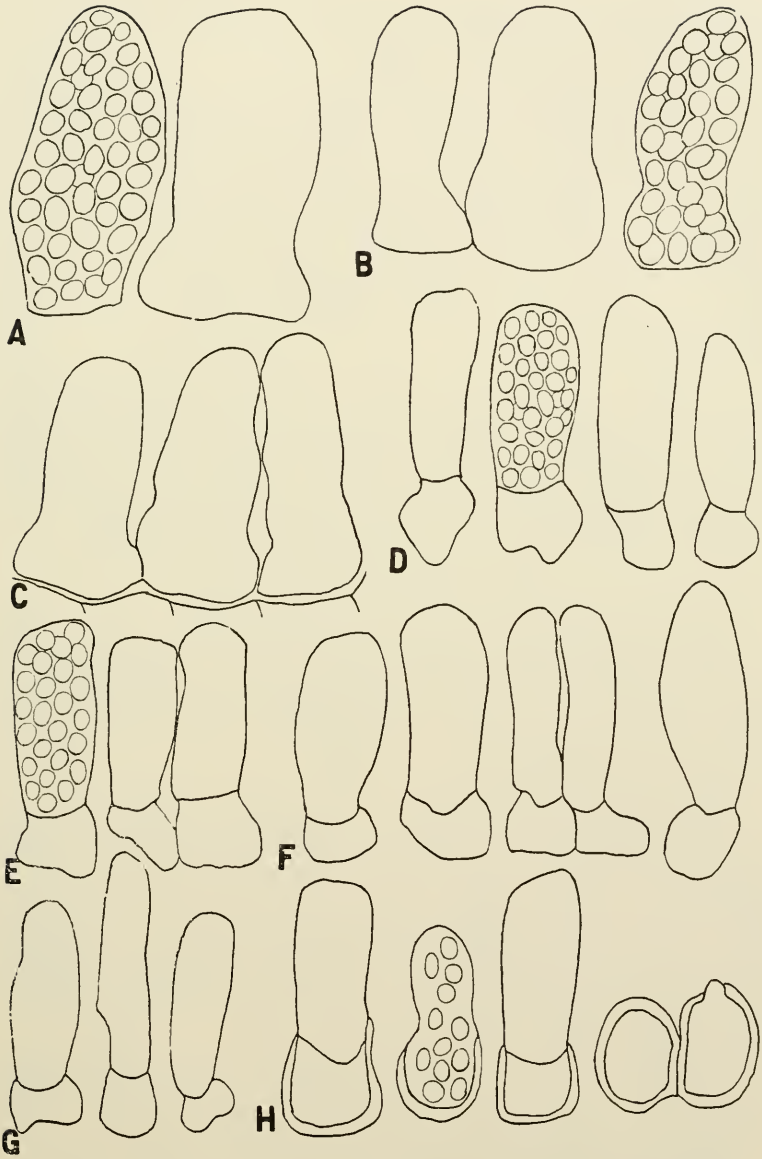

FIG. 21. A-C, asci (× 900) of *Taphrina japonica*, (B, as *T. alni-japonicae*, C, as *T. macrophylla*). D-H, *T. occidentalis*; D, E, on *Alnus rubra*; F, *A. tenuifolia*; G, *A. sinuata*; H, *A. rhombifolia*.

The asci are alike in form and size. Measurements of the asci of the three forms are given above. Asci of each fungus may widen at the base to a broad diameter of 40μ.

Ray (l. c.) states that in *Taphrina japonica* "the basal portion of the ascus is rounded and not widened as is often the case of the asci on the leaves of *A. rubra*." Actually the asci of *Taphrina japonica*, of *T. alni-japonicae* and of the fungus on *Alnus rubra* are alike. They may be rounded at the base, or truncate and widened, the widened portion often taking the form of a bilateral or unilateral foot. Since there are no morphological differences between these three fungi they are hereby declared synonymous as *Taphrina japonica* Kusano.

The fungus deforming the leaves of *Alnus rubra* had been described and discussed (Mix, 1939) before Ray's description appeared, the question having been left open as to its identity with the two Japanese fungi. The collection designated as the type of *T. macrophylla* was not the earliest collection of the fungus, that being the one made by Boyce at Hebo, Oregon, May 9, 1923.

50. *Taphrina occidentalis* Ray

Taphrina occidentalis Ray, Mycologia **31**:56-75. 1939.

Causing tongue-like enlargements of bracts of female catkins of *Alnus rhombifolia* Nutt., *A. rubra* Bong, *A. sinuata* Ryd., and *A. tenuifolia* Nutt. Also causing small puffed or curled areas on the leaves of *A. rhombifolia*.

Mycelium subcuticular.

Asci covering surface of outgrowth, cylindric or cylindric-clavate, rounded or truncate at the apex, with a stalk cell that is commonly broader than long, truncate, rounded, pointed, or irregular below, seated or somewhat inserted between epidermal cells. Ascospores eight, round, ovate, or elliptic, frequently budding in the ascus, filling it with smaller ovate or elliptic blastospores. Asci emerging from the chlamydospore (ascogenous cell) by rupture of the chlamydospore wall. (Fig. 21, D-H, Fig. 22, A.)

Dimensions: Of *asci*, 20-60μ × 8-20μ; of *stalk cells*, 5-23μ × 7-23μ; of *ascospores*, 4-6μ × 3.5-6μ; of *blastospores*, 3.5-5μ × 3-4μ.

Distribution: Western North America.

Material examined: Alnus rhombifolia. CALIFORNIA: Lake Co., Putah Creek, Sept., 1931, H. E. Parks (Herb. Univ. Calif. 3883); Monterey Co., Sur River, Aug., 1903, W. R. Dudley (Phanerogam. Herb. Stanford Univ.); Santa Clara Co., Los Gatos Creek, Oct. 11,

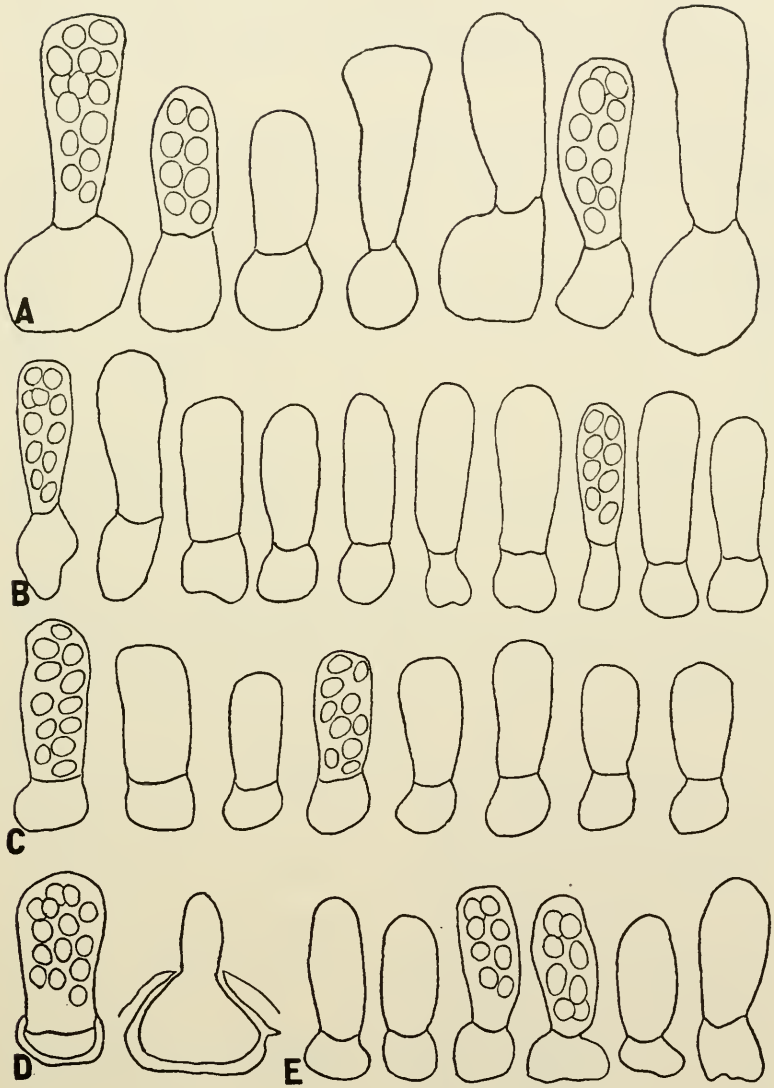

Fig. 22. Asci (×900) of A, *T. occidentalis* on *Alnus rhombifolia;* B, *T. tosquinetii* on *A. glutinosa;* C, *A. crispa* var. *mollis;* D, the same showing emergence of ascus from chlamydospore; E, *Taphrina viridis.*

1902, W. R. Dudley (Phanerogam. Herb. Stanford Univ.). OREGON: Prospect, Rogue River, Aug. 7, 1929, G. D. Darker (Herb. Arnold Arboretum, 456); Sucker Creek below junction with Grayback Creek, Aug. 14, 1929, G. D. Darker (Herb. Arnold Arboretum 575).

A. rubra. BRITISH COLUMBIA: D'Arcy, June 28, 1931, J. R. Hansbrough (Herb. J. R. H. 605); Owl Creek, June 18, 1930, *id.* (Herb. J. R. H. 606); Vancouver Island, Sooke, July, 1938, Malcolm Wilson. CALIFORNIA: Mill Valley, H. E. Parks (Fungi of California 2596); Humboldt Co., Sur P. O., Aug. 3, 1903, W. R. Dudley (Phanerogam. Herb. Stanford Univ.); Siskiyou Co., Klamath Nat. For., Deer Camp Ranger Station, Aug. 26, 1913, E. P. Meinecke and J. S. Boyce (Herb. J. S. B. 278). OREGON: Corvallis, Jan. 30, 1938, Wm. Bridge Cooke; Grant's Pass, Sept. 5, 1917, J. R. Weir (Herb. J. R. W. 5214. Type.)

A. sinuata. OREGON: Government Camp, July 23, 1929, G. D. Darker (Herb. Arnold Arboretum 357); Oregon Caves, Lake Mountain Trail, Aug. 12, 1929, G. D. Darker (Herb. Arnold Arboretum 532).

A. tenuifolia. IDAHO: Clearwater Co., Elk River, Aug. 1929, E. E. Hubert (Herb. J. S. B. 2073); Clearwater Nat. For., Bungalow Ranger Station, July 31, 1931, J. R. Hansbrough (Herb. J. R. H. 607); Crystal Creek, Aug. 2, 1934, H. G. Lachmund and J. S. Boyce (Herb. J. S. B. 2325). MONTANA: Glacier Nat. Park, Aug., 1933, H. E. Bailey (Herb. Univ. California). OREGON: Oregon Caves, Head of Limestone Creek, Aug. 15, 1929, G. D. Darker (Herb. Arnold Arboretum 585). WASHINGTON: Walla Walla Co., Blue Mountain, Aug. 2, 1896, C. V. Piper (Washington Flora 401).

On leaves of *Alnus rhombifolia.* CALIFORNIA: Mendocino Co., May, 1939, H. N. Hansen.

At the time of earlier publication (1939) this fungus was considered to be a variant of *Taphrina robinsoniana.* Ray (1939) has since described it as a separate species. The asci of *Taphrina occidentalis* are somewhat longer and wider, and the stalk cell is wider than in *T. robinsoniana. Taphrina occidentalis* shows the further peculiarity (not reported for *T. robinsoniana*) that the chlamydospore wall breaks to allow emergence of the ascus.

The form on leaves of *Alnus rhombifolia* has stalk cells that are slightly wider and more rounded than in any of the forms on catkins. The ascus emerges from the chlamydospore in the manner typical for this species. It is not impossible that this form on

leaves is a different species but for the time at least it seems best to include it in *Taphrina occidentalis*.

51. *Taphrina viridis* (Sadeb.) Maire

Taphrina viridis (Sadeb.) Maire, Bull. Soc. Bot. France 4e ser. 10:166-176. 1910.
Exoascus viridis Sadebeck (Jaap, Deutsch Bot. Monatschr. 19:75-76. 1901).
Taphrina alnastri Lagerheim, Vestergren Micr. Sel. Exs. 720. 1903.

Causing small, round, pale green or yellow spots (like those produced by *T. sadebeckii*) on leaves of *Alnus viridis* DC.

Mycelium intercellular.

Asci amphigenous, scattered, short-cylindric, or ellipsoidal-oblong, rounded at the apex, stalk cells broad, rounded or truncate below, inserted. Ascospores eight, budding in the ascus, ovate to elliptic. Fig. 22, E.)

Dimensions: Of *asci*, 20-30μ × 7-15μ; of *stalk cells*, 7-13μ × 8-18μ; of *ascospores*, 4.5-5μ × 4-4.5μ.

Distribution: Germany, Austria (Brenner Post, Bad Ratzes), Italian Alps, Scandinavia (according to Saccardo).

Material examined. GERMANY: Baden, Höllenthal, June 18, 1903, G. Lagerheim (Micr. Sel. Exs. 720. Type of *T. alnastri*); *ibid.*, July, 1903, *id.* (Bot. Mus. Stockholm).

This fungus is very similar to *Taphrina sadebeckii* but, as mentioned above, *Alnus viridis* is clearly not susceptible to attack by the latter fungus, and it seems best to retain the two species as distinct.

HOST INDEX TO SPECIES ON BETULACEAE

Alnus crispa (Ait.) Pursh. var. *mollis* Fern.	*Taphrina tosquinetii* (Westend.) Tul.
Alnus glutinosa Gaertn.	*Taphrina amentorum* (Sadeb.) Rostr. *Taphrina sadebeckii* Johans. *Taphrina tosquinetii* (Westend.) Tul.
Alnus hirsuta Turcz.	*Taphrina amentorum* (Sadeb.) Rostr. *Taphrina sadebeckii* Johans.
Alnus hirsuta Turcz. var. *sibirica* Schneid.	*Taphrina sadebeckii* Johans.
Alnus hybrida A. Br.	*Taphrina amentorum* (Sadeb.) Rostr. *Taphrina tosquinetii* (Westend.) Tul.
Alnus incana Moench.	*Taphrina amentorum* (Sadeb.) Rostr. *Taphrina epiphylla* Sadeb. *Taphrina robinsoniana* Gies.
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Alnus incana Moench. var. *monstrosa* Winkl.	*Taphrina epiphylla* Sadeb.
Alnus japonica Sieb. and Zucc.	*Taphrina japonica* Kus.
Alnus rhombifolia Nutt.	*Taphrina occidentalis* Ray
Alnus rubra Bong.	*Taphrina amentorum* (Sadeb.) Rostr. *Taphrina japonica* Kus. *Taphrina occidentalis* Ray
Alnus rugosa Spreng.	*Taphrina robinsoniana* Gies. *Taphrina sadebeckii* Johans.
Alnus sinuata Rydb.	*Taphrina occidentalis* Ray
Alnus tenuifolia Nutt.	*Taphrina occidentalis* Ray

Alnus viridis DC.	*Taphrina viridis* Maire
Betula aurata Bechst.	*Taphrina betulina* Rostr.
Betula carpatica Waldst.	*Taphrina betulina* Rostr.
Betula ermani Cham.	*Taphrina betulicola* Nish. *Taphrina nana* Johans.
Betula fontinalis Sarg.	*Taphrina americana* Mix *Taphrina boycei* Mix
Betula fruticosa Pall.	*Taphrina carnea* Johans.
Betula glandulosa Michx.	*Taphrina bacteriosperma* Johans. *Taphrina carnea* Johans.
Betula humilis Schrank.	*Taphrina carnea* Johans.
Betula intermedia Thom.	*Taphrina bacteriosperma* Johans. *Taphrina betulae* (Fkl.) Johans. *Taphrina betulina* Rostr. *Taphrina carnea* Johans. *Taphrina nana* Johans.
Betula japonica Sieb.	*Taphrina nana* Johans.
Betula lutea Michx.	*Taphrina americana* Mix *Taphrina carnea* Johans.
Betula medwediewi Reg.	*Taphrina betulae* (Fkl.) Johans.
Betula nana L.	*Taphrina bacteriosperma* Johans. *Taphrina betulina* Rostr. *Taphrina carnea* Johans. *Taphrina nana* Johans.
Betula occidentalis Hook.	*Taphrina boycei* Mix
Betula papyrifera Marsh.	*Taphrina americana* Mix *Taphrina carnea* Johans. *Taphrina flava* Farl.
Betula pendula Roth.	*Taphrina betulae* (Fkl.) Johans. *Taphrina betulina* Rostr. *Taphrina carnea* Johans. *Taphrina nana* Johans.
Betula populifolia Ait.	*Taphrina flava* Farl.
Betula pubescens Ehrh.	*Taphrina bacteriosperma* Johans. *Taphrina betulae* (Fkl.) Johans. *Taphrina betulina* Rostr. *Taphrina carnea* Johans. *Taphrina nana* Johans.
Carpinus betulus L.	*Taphrina carpini* (Rostr.) Johans.
Carpinus caroliniana Walt.	*Taphrina australis* (Atk.) Gies.
Carpinus orientalis Mill.	*Taphrina carpini* (Rostr.) Johans.
Corylus americana Marsh. *Corylus heterophylla* Fisch. *Corylus rostrata* Ait. *Corylus sieboldiana* Blume	*Taphrina coryli* Nish.
Ostrya carpinifolia Scop.	*Taphrina ostryae* Massal.
Ostrya virginica Willd.	*Taphrina virginica* Sadeb.

IV. SPECIES ON FAGACEAE

Fagus, Nothofagus, Castanopsis, Quercus

Laubert (1928) lists *Taphrina fagi* Lamb., as occurring on *Fagus* sp. in North America. No specimen of such a fungus could be found in the Berlin Museum, whose collection Laubert used in writing his account of known species. When appealed to by letter in 1938 he was unable to recall the source of his information. Thorough search of the literature has yielded no other reference to such a fungus.

52. *Taphrina entomospora* Thaxter

Taphrina entomospora Thaxter, Bot. Gaz. **50**:435. 1910.
Exoascus entomosporus (Thaxt.) Saccardo and Trotter, Sylloge Fungorum **22**:765.
Entomospora antarctica (Sacc.) Jaczewski, Pocket key for the determination of fungi. Part I. Exoascales. Leningrad. 1926.

Causing yellowing (without enlargement or thickening) of leaves of *Nothofagus antarctica* Oerst. All the leaves of a shoot may be attacked.

Mycelium subcuticular.

Asci hypophyllous, subcylindric, rounded or subtruncate at the apex, provided with a stalk cell which is usually broader than the ascus. Ascospores eight, described by Thaxter as bearing appendages of two orders.

Dimensions: Of *asci,* 36-53μ × 10-17μ; of *stalk cells,* 10-13μ × 17-23μ. (Thaxter reports asci 55-60μ × 13-15μ, perhaps including the stalk cell in his measurements); of *ascospores,* 3.5-6μ × 2-4.5μ; of *blastospores,* 10-23μ × 0.5-1.0μ. (Thaxter reports ascospores as 9-10μ × 3-4μ, with terminal appendages 8-12μ × 3-5μ, subterminal appendages 15-25μ × 0.8μ.) (Fig. 23, A.)

Distribution: Patagonia.

Material examined: Chile: Puntas Arenas, Feb., 1906, R. Thaxter (Type).

Perhaps the portion of material examined was not so favorable as that studied by Thaxter. Many asci were old and empty. Only a few appendaged spores were seen, and these were not so beautifully regular as those seen by Thaxter. The appendages looked like narrow elongate buds, and many asci contained numerous filiform blastospores. Most ascospores observed were elliptic, and either lacked appendages or bore one or more short, narrow buds.

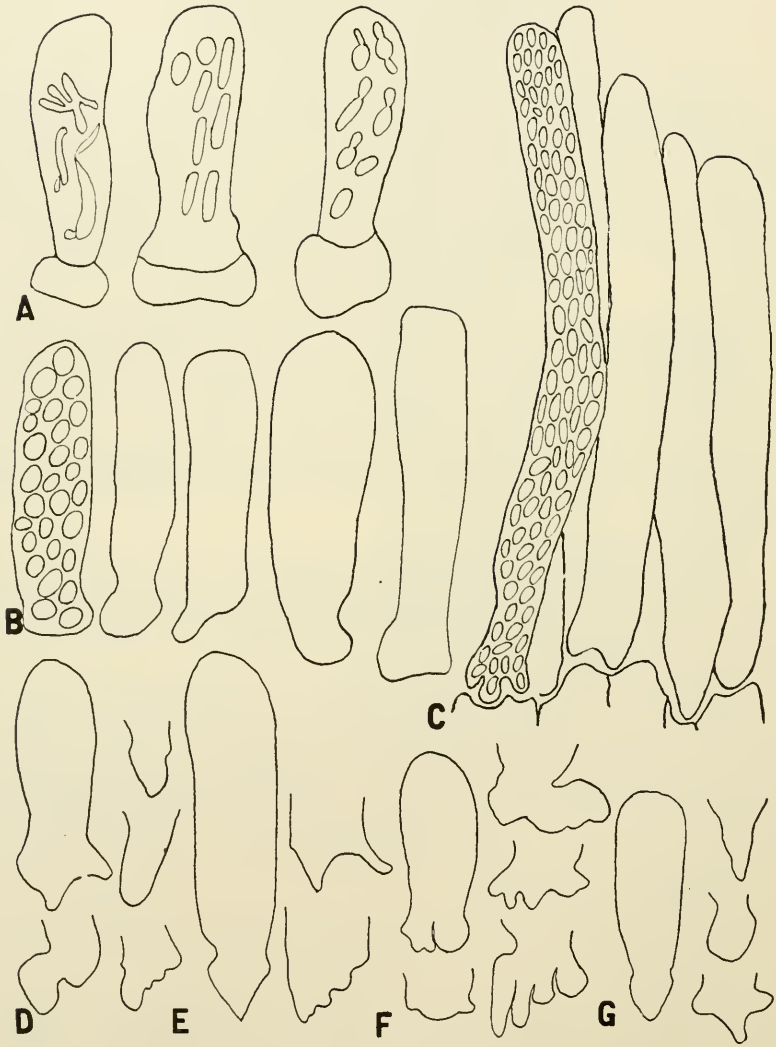

FIG. 23. Asci of A, *Taphrina entomospora;* B, *T. kusanoi;* C, *T. castanopsidis.* D, outlines of asci and ascus-bases of *T. caerulescens* on *Quercus gambelii;* E, *Q. mongolica;* F, *Q. prinoides;* G, *Q. utahensis.* All × 900.

53. *Taphrina castanopsidis* Jenkins

Taphrina castanopsidis Jenkins, Mycologia **28**:31-34. 1936.

Causing convex-concave spots on leaves of *Castanopsis chrysophylla* DC.

Mycelium intercellular.

Asci very long, cylindric, narrow, rounded at the apex, narrowed at the base into one or more short rhizoidal extensions, inserted between epidermal cells, no stalk cell present. Ascospores round, eight, budding in the ascus and filling it with smaller ovate to elliptic blastospores.

Dimensions: Of *asci,* 80-165μ × 10-17μ; of *ascospores,* diameter up to 10μ (according to Jenkins); of *blastospores,* 3-5μ × 1.5-2.5μ. (Fig. 23, C.)

Distribution: California.

Material examined: California: Calaveras Co., Dorrington, Aug. 16, 1934, J. S. Boyce (Herb. J. S. B. 2287); region of the upper Sacramento, July 24-Aug. 10, 1894, Sisson (Plants Univ. Calif., 121 Fungi of Calif. as *T. castanicola* E. and E. n. sp.); Siskiyou Co., Mt. Shasta, Aug. 30, 1937, Wm. Bridge Cooke.

54. *Taphrina kusanoi* Ikeno

Taphrina kusanoi Ikeno, Flora **92**:1-31. 1903.

Causing small (up to 1 cm. diam.) convex-concave spots on leaves of *Castanopsis cuspidata* Schottky (*Pasania cuspidata* Oerst.).

Mycelium intercellular.

Asci hypophyllous, cylindric, rounded at the apex, often widened at the base, or provided with a distinct foot, lacking a stalk cell. Ascospores not observed, asci filled with round, ovate, or elliptic blastospores, some of them very small. (Fig. 23, B.)

Dimensions: Of *asci,* 36-80μ × 12-20μ (102-117μ × 13-19μ according to Ikeno); of *blastospores,* 2-5μ × 2-3μ or very minute.

Distribution: Japan.

Material examined: Japan: Idzen, Atanei, April 13, 1895; Mt. Tsukuba, May, 1900, Kusano; *ibid.,* June 19, 1929, *id.;* Tokyo, Saginomiya, June 19, 1903, Y. Shibasaksi (Herb. Morioka Imp. Coll. Agric. and For.).

If this species actually possesses asci of the size given by Ikeno, the possibility of its synonymy with *Taphrina castanopsidis* may arise. However, in specimens examined the asci were definitely shorter than those of *T. castanopsidis* and the expanded foot of the ascus is a distinguishing feature.

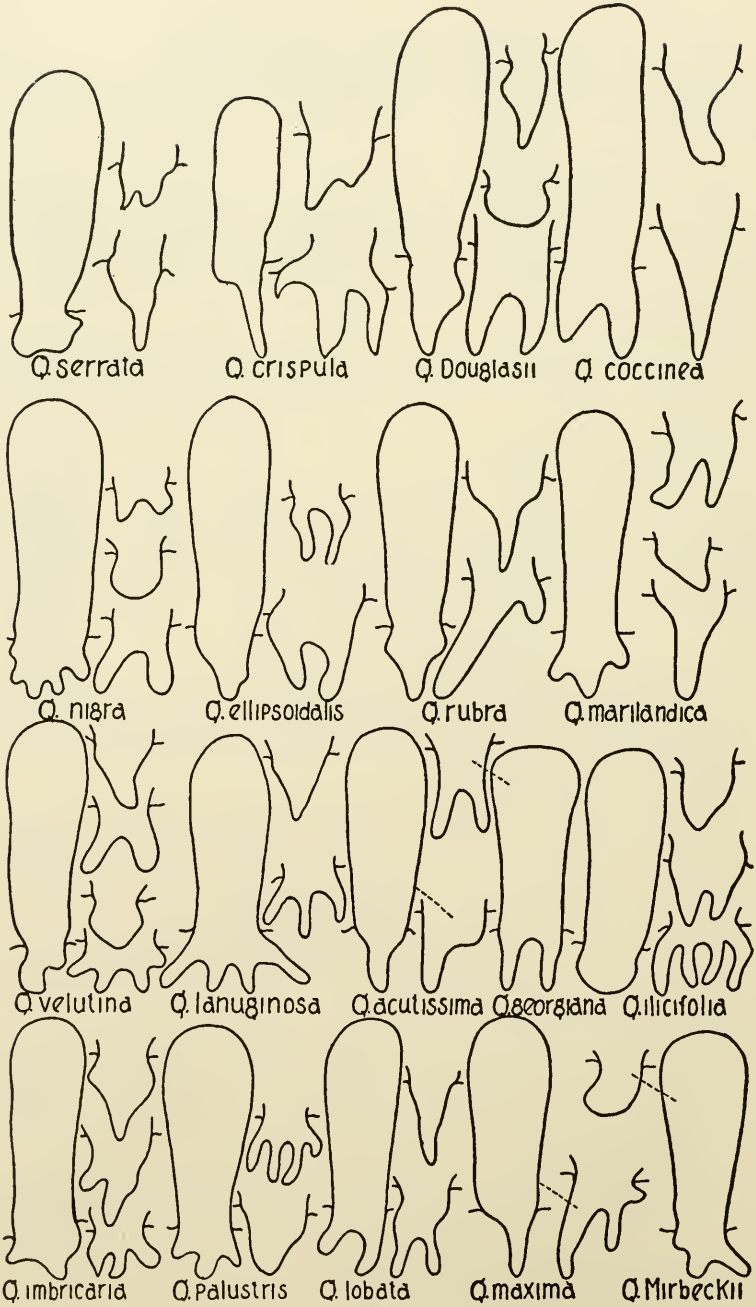

FIG. 24. Asci and ascus-bases (× 900) of *Taphrina caerulescens*, on species of *Quercus*.

55. *Taphrina caerulescens* (Desm.) Tulasne

Taphrina caerulescens (Desm.) Tulasne, Ann. Sci. Nat. 5e Ser. Bot. **5**:122-136. 1866.
Ascomyces caerulescens Desmaziéres, Ann. Sci. Nat. 3e Ser. Bot. **10**:342-361. 1848.
A. alutaceus Thümen, Verhandl. K. K. Zool. Bot. Ges. Wien. **29**:523-524. 1880.
A. extensus Peck, New York State Mus. Nat. Hist. Ann. Rept. **39**:30-70. 1886.
A. rubrobrunneus Peck, New York State Mus. Nat. Hist. Ann. Rept. **40**:39-77. 1887.

Causing small to large, convex-concave, slightly swollen spots or blisters on leaves (occasionally deforming the whole leaf, but not forming true witches' brooms) on many species of *Quercus*. (A complete list, as far as known, is given below.)

Mycelium intercellular.

Asci epiphyllous or hypophyllous, very variable in size and shape, cylindric or clavate, usually rounded at the apex, at the base blunt, rounded, or truncate, and seated or slightly inserted; or else wedge-shaped, pointed, or with rhizoidal appendages, and more or less deeply inserted between epidermal cells. Stalk cells lacking. Ascospores rarely seen, asci filled with round, ovate, or elliptic blastospores. (Fig. 23, D-G, Fig. 24, 25.)

Dimensions of *asci* in microns

Quercus acutissima Carruth	50- 92 × 15-27
Quercus agrifolia Née	46- 68 × 15-19
Quercus alba L.	49-103 × 15-34
Quercus borealis Michx.	46- 76 × 15-30
Quercus cerris L.	30- 72 × 11-23
Quercus cinerea Michx.	42- 68 × 15-23
Quercus coccifera L.	46- 84 × 11-27
Quercus coccinea Muench.	68-118 × 13-30
Quercus crispula Blume	46- 92 × 14-23
Quercus dentata Thunb.	57- 84 × 13-22
Quercus douglasii Hook. and Arn.	65-118 × 19-28
Quercus ellipsoidalis Hill	57-104 × 15-30
Quercus fruticosa Brot.	38- 65 × 11-19
Quercus gambelii Nutt.	53- 83 × 20-27
Quercus geminata Small	75-120 × 15-27
Quercus georgiana Curtis	49- 84 × 19-30
Quercus ilicifolia Wangh.	46- 84 × 15-27
Quercus imbricaria Michx.	49- 91 × 11-30
Quercus kelloggii Newb.	65-106 × 19-27
Quercus laurifolia Michx.	57- 95 × 15-27
Quercus lobata Née	50- 87 × 17-23
Quercus macrocarpa Michx.	38- 76 × 15-27
Quercus marilandica Muench.	53-103 × 11-26
Quercus maxima Ashe	46- 95 × 13-30
Quercus mirbeckii Dur.	46- 84 × 19-27
Quercus mongolica Turcz.	76-109 × 20-26
Quercus nigra L.	60-102 × 19-34
Quercus palustris Moench	58- 84 × 19-27

Quercus phellos L.	46- 76 × 11-19
Quercus prinoides L.	32- 58 × 18-22
Quercus pubescens Willd. (*Q. lanuginose*)	43- 84 × 15-27
Quercus rubra L.	57- 99 × 17-25
Quercus robur L.	50- 84 × 19-25
Quercus serrata Thunb.	64- 92 × 18-30
Quercus sessiliflora Salisb.	46- 72 × 15-27
Quercus stellata Wangh.	57- 80 × 15-27
Quercus undulata Torr.	38- 84 × 15-27
Quercus utahensis Rydb.	40- 73 × 20-27
Quercus velutina Lam.	49- 95 × 15-27
Quercus virginiana Mill.	68- 95 × 15-23

Ascus-size limits for all known host-species: 30-120μ × 11-34μ.

Material examined: Quercus acutissima. JAPAN: Iwate, Mizuyama, July 25, 1927, K. Togashi (Herb. K. T. 2899); *ibid.*, June 16, 1932, *id.* (Herb. Morioka Imp. Coll. Agric. and For.).

Q. agrifolia. CALIFORNIA: Monterey Co., April, 1938, H. Earl Thomas; *ibid.*, June 16, 1932, H. N. Hansen.

Q. alba. MASSACHUSETTS: Waltham, June 20, 1935, D. H. Linder. NEW YORK: Ithaca, 1938, W. W. Ray. VIRGINIA: Victoria, June 9, 1936, S. A. Wingard.

Q. borealis. CONNECTICUT: East Granby, July 4, 1934, H. G. Eno (U. S. D. A. For. Path. 81724). MASSACHUSETTS: Petersham, July 26, 1928, J. S. Boyce (Herb. J. S. B. 2028). MICHIGAN: Huron Co., Sand Point, near Bayport, July 4, 1938, E. A. Bessey. NEW HAMPSHIRE: Conway, June 8, 1921, P. Spaulding (For. Path. 45371). TENNESSEE: Great Smoky Mts., Nat. Park, Rich Mt., June 24, 1934, L. R. Hesler.

Q. cerris. ALGIER: Guide, Kofouri, Sept. 16, R. Maire and M. Pettitmengin (Miss. Bot. Or. 1906). ITALY: Mt. Penice, Vocarezza (Cav. F. Longob. Exs. 73a); Ponte Organasco (Cav. F. Longob. Exs. 73b).

Q. cinerea. NORTH CAROLINA: Aiken, 1878, H. W. Ravenel (Thüm, Myc. Univ. 2065).

Q. coccifera. ALGIER: Marabout de Sidi-Youssef, Bouzaria, May 8, 1913, R. Maire (Myc. Bor. Afr.). FRANCE: Hyères, June 16 (Rab.-Wint. F. Eur. 3537). GREECE: Mt. Ypsili-Keryphi, near monastery Renive, July 12, 1906, R. Maire (Miss. Bot. Or. 240). MOROCCO: Cap Spartel, April 26, 1924, R. Maire (Champ. Afr. Nord. 8403).

Q. coccinea. GEORGIA: Athens, May 14, 1936, J. H. Miller. MICHIGAN: Huron Co., Sand Point, near Bayport, July 4, 1938, E. A. Bessey. NEW YORK: Ithaca, South Hill Marsh, June 26, 1940, A. J. M.

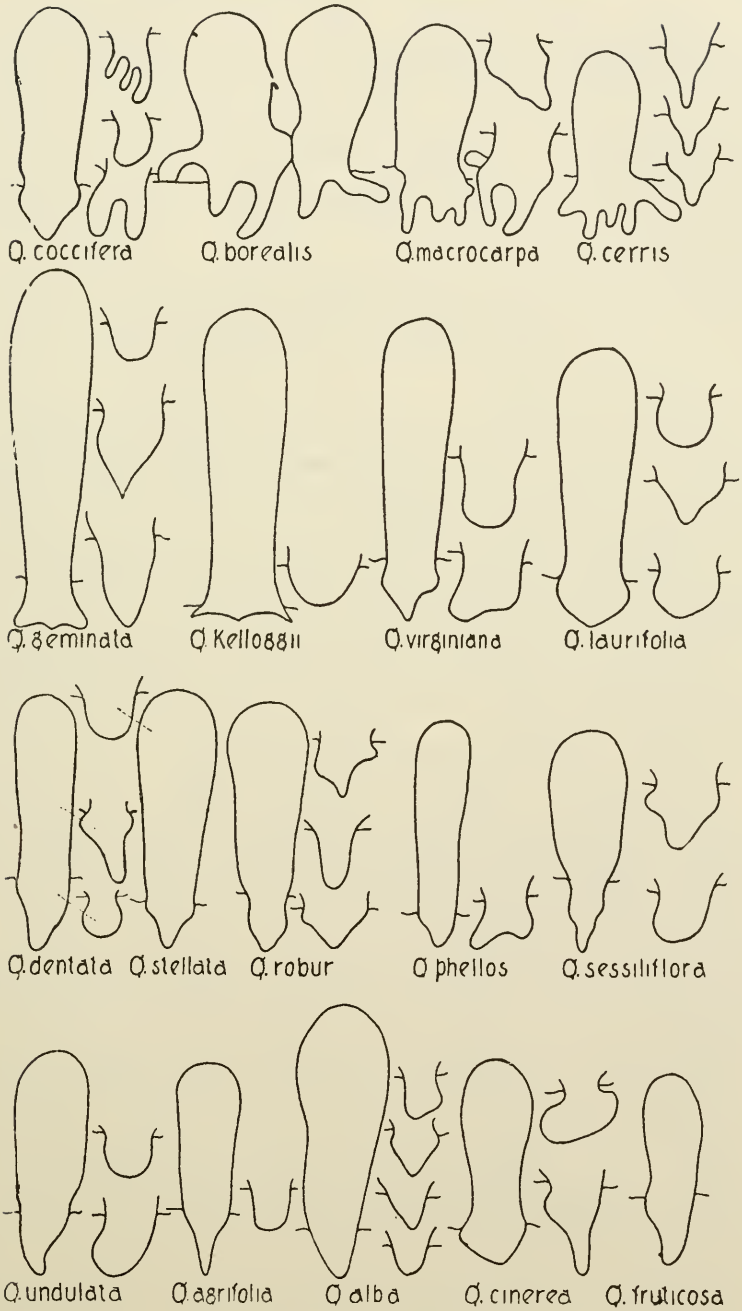

FIG. 25. Asci and ascus bases (×900) of *Taphrina caerulescens*, on species of *Quercus*.

Q. dentata. SASKATCHEWAN: Indian Head, July 25, 1935, B. J. Sollano (Herb. Univ. Toronto).

Q. douglasii. CALIFORNIA: Lake Co., May 3, 1936, H. N. Hansen.

Q. ellipsoidalis. WISCONSIN: Lyndon Station, July 4, 1917, J. J. Davis (Herb. Univ. Wisconsin).

Q. fruticosa. LUSITANIA: Coimbra, summer 1879, A. F. Möller (Myc. Univ. 1553).

Q. gambelii. WYOMING: Medicine Bow Nat. For., Hayden Divn., Sandstone Ranger Sta., July 13, 1939, W. G. Solheim.

Q. geminata. NORTH CAROLINA: May, 1936, R. F. Poole.

Q. georgiana. GEORGIA: Stone Mt., April 26, 1925, J. H. Miller (Herb. Univ. Georgia).

Q. ilicifolia. NEW HAMPSHIRE: W. Ossipee, July 19, 1910, W. G. Farlow (Farl. Herb.). NEW YORK: Sam's Point, Aug., J. Dearness (Herb. J. D.). VIRGINIA: Bald Knob, July, 1918, G. H. Chapman (Herb. Mass. Agric. Coll. 2486).

Q. imbricaria. MISSOURI: Perryvale, C. H. Demetrio (Rab-Pazsch. F. Eur.). NORTH CAROLINA: Greensboro, June, 1934, A. F. Thiel; *ibid.*, spring 1934, E. M. Martin.

Q. kelloggii. CALIFORNIA: Lake Co., May 3, 1936, H. N. Hansen.

Q. laurifolia. FLORIDA: Gainesville, May 20, 1935, G. F. Weber; *ibid.*, April 28, 1941, *id.*

Q. lobata. CALIFORNIA: 1935, H. N. Hansen.

Q. macrocarpa. ALBERTA: J. Dearness (Herb. J. D.). IOWA: W. Okeboji, June 19, 1932, G. W. Martin. KANSAS: Hays, June 6, 1930, E. Bartholomew (N. A. F. 10957, as *T. extensa*); Lawrence, Haskell Meadow, May 14, 1946, A. J. M. WISCONSIN: Granville, July 17, 1867, I. A. Lapham.

Q. marilandica. KANSAS: Baldwin, June, 1933, A. J. M.; *ibid.*, June 2, 1936, *id.*; *ibid.*, May 31, 1937, *id.* MISSOURI: Bagnell Dam, Osage Beach, June 3, 1937, A. J. M.; Seligman, July 12, 1922, R. P. White. VIRGINIA: Princess Anne Co., May 18, 1926, H. T. Cook.

Q. maxima. CONNECTICUT: Collinsville, Aug., 1937, A. J. M.; New Haven, June 23, 1928, *id.*; *ibid.*, June 30, 1928, *id.* GEORGIA: Athens, May 14, 1936, J. H. Miller; Experiment, May 18, 1936, J. L. Weimer. MAINE: Kittery Point, June, 1899, R. Thaxter (Farl. Herb.). MASSACHUSETTS: Amherst, Aug. 19, 1937, A. J. M.; Manchester, Sept. 4, 1928, R. J. Eaton (For. Path. 45878); Sunderland, Aug., 1934, R. H. Thompson. NEW HAMPSHIRE: Canaan, Sept. 23, 1931, E. D. Farnsworth (For. Path. 51682). NEW YORK: Columbia Co., near Hudson, Aug., 1919, A. J. M.; ITHACA: Fall Creek Ravine,

near Beebe Lake, June 27, 1940, *id.;* Poultry Woodlot, Aug. 18, 1929, D. S. Welch (Herb. D. S. W. 819); Klinewoods Road, June 21, 1940, A. J. M.; Sandlake, Sept., 1886, C. H. Peck (*Type* of *T. rubrobrunnea*). Ontario: Muskoka, Muldrew Lake, July 31, 1936, D. S. Welch (Herb. D. S. W. 1286). North Carolina: 1937, J. N. Couch (Herb. Univ. North Carolina, 10724). Tennessee, June 20, 1937, C. D. Sherbakoff. Wisconsin: June 2, 1913, J. J. Davis (Herb. Univ. Wisconsin).

Q. mirbeckii. Morocco: Janger a Agla, April 25, 1924, R. Maire (Champ. Afr. Nord. 8404).

Q. mongolica. Russia: Nyushno-Yssyriiskii Krai, June 13, 1912, N. Naumov (Herb. Sydow).

Q. nigra. Alabama: Auburn, May 8, 1890, G. F. Atkinson (Econ. F. 180). Florida: Gainesville, April 28, 1941, G. F. Weber. Massachusetts: Melrose, June 16, 1936, R. H. Thompson. North Carolina: Durham, F. A. Wolf (Herb. Univ. Tennessee 9978).

Q. palustris. Georgia: Athens, May 14, 1936, J. H. Miller.

Q. pedunculata. Germany: Schleswig-Holstein, Island Sylt, Lornsenhain, near Westerland, May 8, 1911, H. and P. Sydow (Myc. Germ.).

Q. phellos. Alabama: Auburn, May 8, 1890, G. F. Atkinson. North Carolina: 1938, F. A. Wolf.

Q. prinoides. Kansas: Vinland, Violet Hill, May 14, 1946. A. J. Mix.

Q. pubescens. Austria: Kaltenleutgeben, Aug., 1879, Thümen (Myc. Univ. 1554, as *Ascomyces alutaceus*). Italy: Verona, Tregagno, autumn 1906, C. Massalongo (Myc. Ital. Exs. 1678).

Q. robur. Ireland: Glengariff, June 18, 1935, A. J. M.

Q. rubra. Alabama: Auburn, May 13, 1890, G. F. Atkinson (Econ. F. 185). North Carolina: Durham, June, 1935, F. A. Wolf.

Q. sessiliflora. Italy: Florence, Vallombrosa, spring 1898, F. Cavara (Myc. Ital. 534). Montenegro: Savnitz, Sept. 30, 1911, E. Vlack (Bubák Herb.).

Q. stellata. Illinois: Mount Vernon, Aug. 6, 1937, G. H. Boewe. South Carolina: Clemson College, June 15, 1935.

Q. undulata. Colorado: Mancos, June 22, 1898, Baker, Earle and Tracy (Farl. Herb.); Ouray, July 4, 1907, Clements (Crypt. Form Colo. 527).

Q. utahensis. Colorado: Glenwood Springs, Aug. 20, 1941, A. J. M.

Q. velutina. ARKANSAS: Fayetteville, May 21, 1935, J. C. Dunegan. CONNECTICUT: Collinsville, Aug. 17, 1937, A. J. M.; New Haven, June 24, 1928, *id.;* New London, June, 1886, W. G. Farlow (Farl. Herb.). MASSACHUSETTS: Hamilton, July, 1927, P. Spaulding (For Path. 16130); Middlesex Fells, A. B. Seymour; Pigeon Cove, July 28, 1890, *id.* (Econ. F. 184b). MISSISSIPPI: Starkville, May 10, 1890, S. M. Tracy (Econ. F. 184a). MISSOURI: Camdenton, June 3, 1937, A. J. M. WEST VIRGINIA: Monongahela Co., near Lake Lynn, July 12, 1935, C. R. Orton. WISCONSIN: Avoca, July 18, 1923, J. J. Davis (Herb. Univ. Wisconsin).

Q. virginiana. VIRGINIA: Princess Anne Co., May 21, 1935, H. T. Cook; *ibid.,* May 18, 1936, *id.*

Besides the hosts listed above *T. caerulescens* is reported on: *Quercus armeniaca* Kotsch in the Caucasus (Jacsewski); *Q. austrina* Poplarville, Mississippi, Aug. 7, 1925, J. L. Weimer; *Quercus conferta* Kit., Romania (letter from Savelescu, 1939); *Q. gunnisonii,* North Cheyenne Canyon, Colorado, July, 1895, L. H. Pammel.

The above account of *Taphrina caerulescens* is taken from the paper by Mrs. Thompson (1940) with a few emendations and studies of additional species by the writer, and Figures 24 and 25 are copied from her illustrations.

Since the chief point of distinction between *Taphrina caerulescens* and *T. kruchii* (see below) lies in the fact that the latter forms witches' brooms, a collection in the Farlow Herbarium becomes interesting. It is labelled: "Taphrina on red oak, Kittery Point, Maine, June, 1899, Thaxter." Enclosed is a slip of paper with the notation, apparently by Thaxter: "T. kruchii."

The specimens show clusters of diseased leaves arising in some cases from the ends of twigs, in some cases from axillary buds. All leaves are reduced in size and deformed throughout the whole blade. No adventitious buds are present and in spite of their suggestive appearance the structures are not true witches' brooms. The asci conform to those of *Taphrina caerulescens* on *Quercus maxima.*

56. *Taphrina kruchii* (Vuill.) Saccardo

Taphrina kruchii (Vuill.) Saccardo, Sylloge Fungorum **10**:68.
Exoascus kruchii Vuillemin, Rev. Mycol. **13**:141-142. 1892.

Causing pronounced witches' brooms with negatively geotropic curvature of twigs, on *Quercus ilex* L.

Mycelium intercellular.

Asci hypophyllous, cylindric to clavate, rounded at the apex,

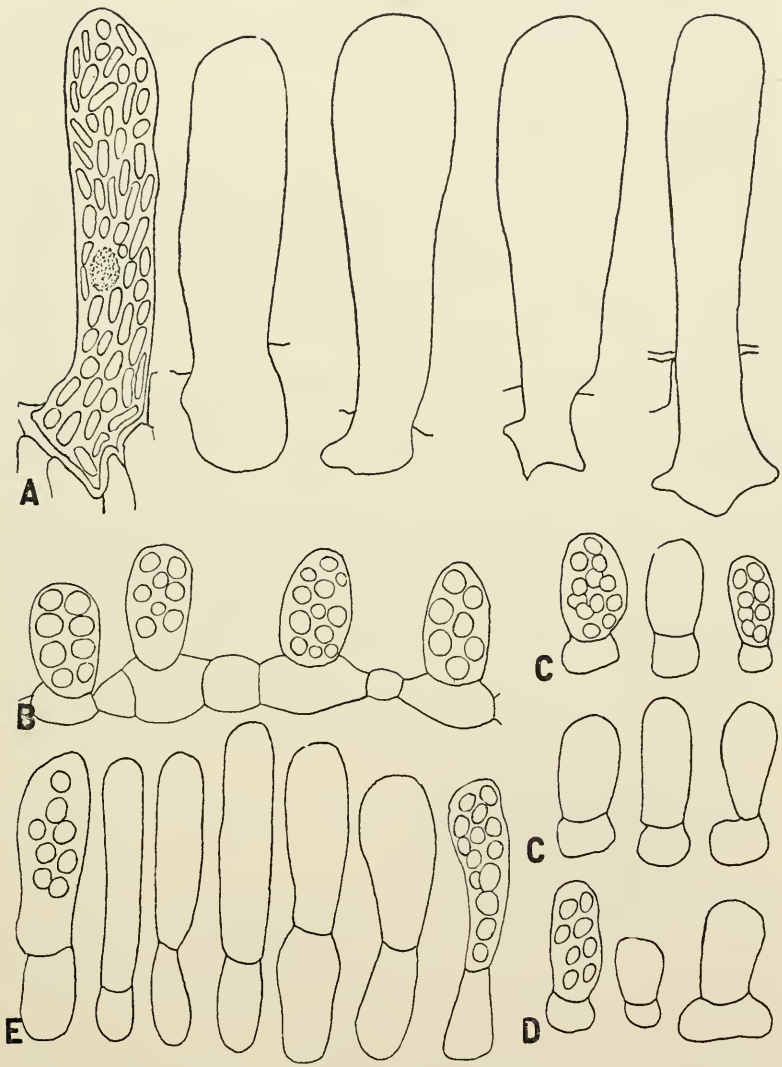

Fig. 26. Asci (× 900) of A, *Taphrina kruchii;* B, *T. ulmi;* C, *T. celtis* on *Celtis australis;* D, *C. tournefortii;* E, *Taphrina bullata.*

without stalk cell. Ascospores eight, asci usually filled with elliptic or rod-shaped blastospores. (Fig. 26, A.)

Dimensions: Of *asci,* 40-100μ × 15-25μ; of *ascospores,* 4μ diam. (Vuillemin); of *blastospores,* 2.5μ × 2μ (Vuillemin); of rod-shaped blastospores, 8-10μ × 1.5-2μ.

Distribution: Mediterranean area.

Material examined: ALGIER: between Babor and Tababor, hill "Tizi n' Souk," May 7, 1912, R. Maire (Myc. Bor. Afr. 98, asci not found). CORSICA: Zuza, Sept. 6, 1901, R. Maire (Micr. Rar. Sel. 662). ITALY: Cagliari, Sette Fratella, July, 1900, Cavara (Myc. It. 687). SARDINIA: Mt. Gennargentii, Aug., 1902, A. Firoi (Myc. It. 1517). SICILY: Albano, June 2, 1914, P. Baccoirini (Herb. R. Mus. Florence).

This fungus, whose asci conform to those of *Taphrina caerulescens,* is retained as a separate species because of its habit of forming witches' brooms, and its probable (though unknown) biological specialization.

The specimen (mentioned above) from Albano, Sicily, obtained on loan from the herbarium of the Royal Museum, Florence, is of a large witches' broom with many crowded adventitious shoots. The twigs show negative geotropic curvature, and the leaves are dwarfed and completely deformed by the fungus.

HOST INDEX TO SPECIES OF *TAPHRINA* ON FAGACEAE

(Exclusive of *Taphrina caerulescens*)

Castanopsis chrysophylla DC
    Taphrina castanopsidis Jenkins
Castanopsis cuspidata Schottky
    Taphrina kusanoi Ikeno
Nothofagus antarctica Oerst.
    Taphrina entomospora Thaxt.
Quercus ilex L.
    Taphrina kruchii Vuill.

IV. SPECIES ON URTICACEAE

Ulmus, Celtis

57. *Taphrina ulmi* (Fkl.) Johanson

Taphrina ulmi (Fkl.) Johanson, Ofvers K. Svensk. Vet. Akad. Forhandl. 1885:20-47. 1886.
Exoascus ulmi Fuckel, Jahrb. Nassau. Verein. Naturk. 27 and 28:1-99. 1873 and 1874.
Exoascus campestris Saccardo, Michelia 2:30-135. 1892.

Causing small, yellowish to brown, unthickened or slightly puffed spots on leaves of *Ulmus alata* Michx., *U. americana* L., *U. fulva* Michx., *U. glabra* Huds., *U. laevis* Pall., *U. montana* With., *U. carpinifolia* Gleditsch var. *suberosa* (Moench.) Rehd.

Mycelium subcuticular.

Asci hypophyllous or sometimes epiphyllous, cylindric or ellipsoid, rounded at apex, with a broad stalk cell. Ascospores eight, round, ovate, or elliptic, often budding in the ascus. (Fig. 26, B.)

Dimensions: Of *asci*, 10-29μ × 7-15μ; of *stalk cells*, 6-10μ × 8-22μ; of *ascospores*, 3-6μ × 3-6μ.

Distribution: Europe, North America.

Material examined: Ulmus alata. Alabama: Tuskegee, March 29, 1897, G. W. Carver (Ellis Herb.). Arkansas: near Fayetteville, May, 1941, received by J. C. Dunegan.

U. americana. Quebec: Duchesnay, 1935, R. Pomerleau; *ibid.*, June 12, 1941, *id.*

U. fulva. Kansas: Baldwin, June 15, 1947, A. J. M. Virginia: Blacksburg, June, 1932, S. A. Wingard (U. S. D. A. Path. and Myc. Coll. 66890).

U. glabra. England: Kent, Ivy Hatch, July 10, 1935, A. J. M. Poland: Pulawy, May 20, 1927, W. Siemaszko (Herb. Inst. Phytopath. Schol. Sup. Varsaviensis). Sweden: Uppsala, June, 1885, C. J. Johanson; Skåne, Pelshult, Aug., 1896, G. Lagerheim.

U. laevis. Germany: Saxony, between Schmilka and Herrnskretchen, May 26, 1899, W. Krieger (F. Sax. 622). Holland: Petersberg, near Maastrecht, Aug., 1885, P. Magnus (Rehm. Asco. 869).

58. *Taphrina celtis* Sadebeck

Taphrina celtis Sadebeck, Jahrb. Hamburg. Wissensch. Anst. **8**:61-95. 1890.
Exoascus celtidis (Sadeb.) Saccardo, Sylloge Fungorum **10**:69.
E. aemiliae Passer., Atti. R. Accad. Lincei, Ser. 4, **6**:457-470. "1889" (1890).

Causing small roundish, gray to brown, very slightly thickened spots, apparent on upper surface only, on leaves of *Celtis australis* L., and *C. tournefortii* Lam.

Mycelium subcuticular.

Asci hypophyllous, cylindric to ellipsoid, rounded at the apex; stalk cell flattened, sometimes broader than the ascus. Ascospores eight, round, ovate, or elliptic, often budding in the ascus. (Fig. 26, C, D.)

Dimensions: Of *asci,* 13-28μ × 8-13μ; of *stalk cells,* 7-10μ × 8-13μ (8-10μ × 25-30μ according to Sadebeck); of *ascospores,* 3.5-5μ × 3.5-4.5μ.

Distribution: southern Europe, north Africa.

Material examined. Celtis australis. ALGIER: Sidi-Madani, Gorges de la Cluffa, May 4, 1913, R. Maire (Myc. Bor. Afr. 170). CAUCASUS: Tiflis, Hortus Botanicus, 1911, G. Nevodowski.

C. tournefortii. HERZEGOVINA: Trebinje, May 9, 1897, C. Barinitz (Herb. Sydow).

HOST LIST FOR *TAPHRINA ULMI* (FKL.) JOHANS

Ulmus alata Michx.
Ulmus americana L.
Ulmus carpinifolia Gleditsch var. *suberosa* (Moench.) Rehrd
Ulmus fulva Michx.
Ulmus glabra Huds.
Ulmus laevis Pall.
Ulmus montana With.

V. SPECIES ON ROSACEAE

Pyrus, Sorbus, Amelanchier, Crataegus, Potentilla, Geum

59. *Taphrina bullata* (Berk.) *Tulasne*

Taphrina bullata (Berk.) Tulasne, Ann. Sci. Nat., 5 Ser., Bot. **5**:122-136. 1866.
Ascomyces bullatus Berkeley, Jour. Roy. Hort. Soc. London. **9**:48. 1854.
Exoascus bullatus (Berk.) Sadebeck, Jahrb. Hamburg. Wissensch. Anst. **10**:5-110. 1893.

Causing small, slightly thickened, bullate, irregular brown spots on leaves of *Pyrus communis* L.

Mycelium subcuticular.

Asci hypophyllous, cylindric, rounded or truncate at the apex, stalk cell as broad as, or narrower than the ascus. Ascospores eight, round, ovate, or elliptic, often budding in the ascus (Fig. 26, E.)

Dimensions: Of *asci,* 23-36μ × 8-15μ (30-40μ × 8-9μ according to Sadebeck); of *stalk cells,* 8-17μ × 5-13μ; of *ascospores,* 4.5-5.5μ × 3.5-4.5μ.

Distribution: Europe.

Material examined: Germany: Berlin, Steglitz, Aug. 18, 1887, P. Magnus; Brandenburg, Tamsel Baumschulen, Aug. 26, 1904, P. Vogel (Myc. Germ. 391). Poland: Zalesczyki, May 25, 1910, A. Wróblewski (Myc. Polon. II 54). Sweden: Uppsala: Bot. Gard., June 8, 1912, O. Juel; Stockholm, Experimentalfältet, June 28, 1939, A. J. M.; *ibid.,* July 25, 1939, *id.;* Växtskyddsanstalt, July 1, 1939, *id.;* Tungelsta, July 13, 1939, *id.*

Buhr (1935) reports having seen in the Bremen Botanic Garden *Taphrina bullata* on *Pyrus betulifolia* Bunge, *P. sinensis* Lindl., and *"P. sinensis* × *salicifolia* × *communis."*

Pyrus sinensis Lindl. is *P. lindleyi* Rehd. and on this host the writer (1947) has described a new species *Taphrina orientalis* (see below). Buhr (l. c.) also states that *T. bullata* occurs at Corte' in Corsica on *P. amygdaliformis* Vill. The fungus is also reported by Tai (1937) as occurring on *P. montana* Nakai, at Port Arthur, Dairen. The report by Rostrup (1890) of *Taphrina bullata* as occurring at Viborg, Denmark, on *Chaenomeles lagenaria* Koidz. (*Cydonia japonica*) is in error. This specimen (obtained on loan from the Copenhagen Museum) is plainly *Pyrus communis,* though perhaps a seedling rather than a cultivated variety.

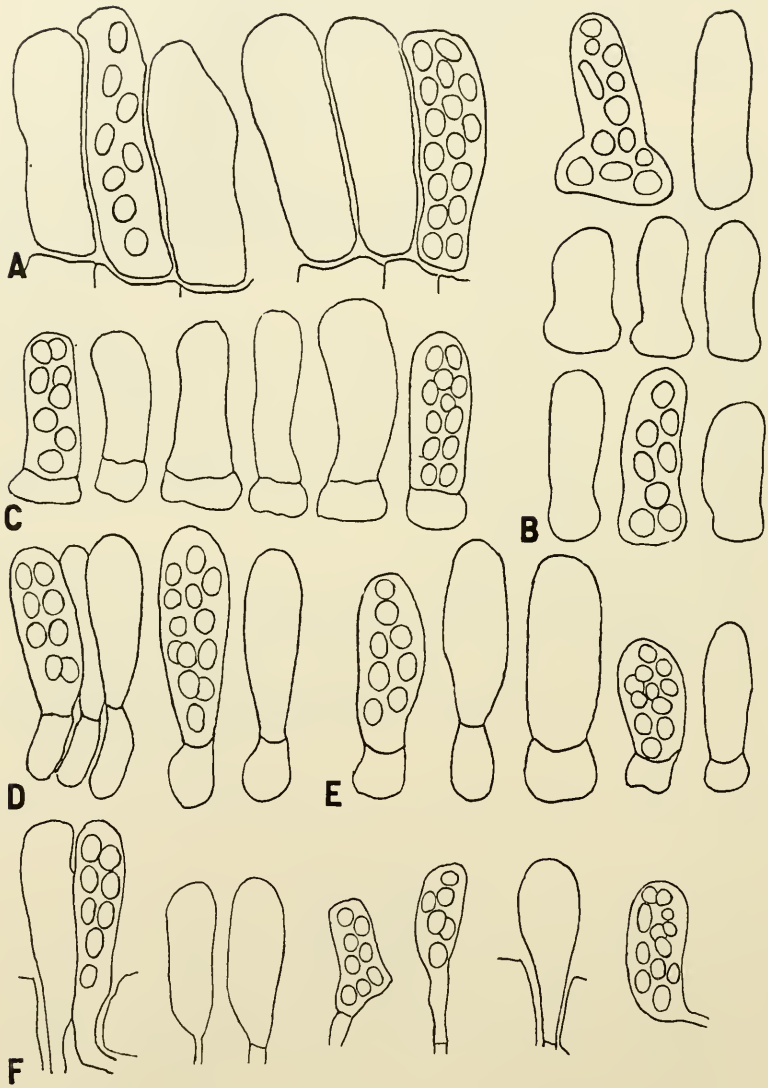

FIG. 27. Asci (× 900) of A, *Taphrina orientalis;* B, *T. piri;* C, *T. sorbi;* D, *T. amelanchieri;* E, *T. crataegi;* F, *T. potentillae.*

60. *Taphrina orientalis* Mix

Taphrina orientalis Mix, Trans. Kansas Acad. Sci. **50**:77-83. 1947.

Causing small (up to 8 mm. diam.) deformed spots on leaves of *Pyrus lindleyi* Rehd.

Mycelium subcuticular.

Asci hypophyllous, cylindric, lacking a stalk cell, seated on the epidermis. Ascospores eight, frequently budding and filling the ascus with blastospores. (Fig. 27, A.)

Dimensions: Of *asci,* 22-46μ × 8-17μ; of *ascospores,* 4-6μ × 4-5μ.

Distribution: Japan.

Material examined: Japan: Pref. Iwate, Morioka, May 30, 1908, G. Yamada (Received from K. Togashi.).

61. *Taphrina piri* Kusano

Taphrina piri Kusano, Bot. Mag. Tokyo **19**:1-3. 1905, and Ann. Mycol. **3**:30-31. 1905.
Exoascus piri (Kus.) Saccardo, Sylloge Fungorum **18**:197.

Causing small, pale, bullate spots or larger curled areas on leaves of *Sorbus alnifolia* K. Koch. (*Pyrus miyabei* Sarg.).

Mycelium subcuticular.

Asci hypophyllous, cylindric, rounded or truncate at the apex, occasionally broadened to a foot below; lacking stalk cells, ascospores eight, round, ovate, or elliptic, frequently budding in the ascus. (Fig. 27, B.)

Dimensions: Of *asci,* 23-42μ × 8-13μ; of *ascospores,* 4-6μ × 3.5-5μ.

Distribution: Japan.

Material examined: Japan: Nikko, June 10, 1904, S. Kusano (duplicate of type, received from Kusano); *ibid., id.* (in Bot. Mus. Stockholm).

62. *Taphrina sorbi* (Jacz.) Mix

Taphrina sorbi (Jacz.) Mix, Univ. Kansas Sci. Bull. **24**:10:151-176. 1936.
Exoascus sorbi Jaczewski, Pocket Key for Determination of Fungi. Part I Exoascales. Leningrad. 1926.

Causing small deformed spots, or leaf-curl in leaves of *Sorbus torminalis* (L.) Crantz.

Mycelium subcuticular.

Asci amphigenous, cylindric, rounded or truncate at the apex; stalk cells broad, flat, ascospores eight, round, ovate, or elliptic, frequently budding in the ascus. (Fig. 27, C.)

Dimensions: Of *asci,* 20-40μ × 10-13μ; of *stalk cells,* 5-7μ × 10-15μ; of *ascospores,* 4-5μ × 4-4.5μ.

Distribution: Caucasus.

Material examined: Russia: Transcaucasia, Kahetia, 1897, A.

Jaczewski (Herb. Inst. Prot. Plants, Sect. Phytopath. Leningrad. Part of type).

63. *Taphrina amelanchieri* Mix

Taphrina amelanchieri Mix, Amer. Jour. Bot. **26**:44-48. 1939.

Causing witches' brooms on *Amelanchier alnifolia* Nutt.

Mycelium subcuticular.

Asci hypophyllous, cylindric to clavate, rounded at apex; stalk cells variable in size and shape. Ascospores eight, round, ovate, or elliptic, frequently budding in the ascus. (Fig. 27, D.)

Dimensions: Of *asci*, 20-34μ × 8-13μ; of *stalk cells*, 8-13μ × 6-12μ; of *ascospores*, 3.5-5.5μ × 3-5μ.

Distribution: California.

Material examined: CALIFORNIA: Siskiyou Co., Yreka, near Frenchtown, June 24, 1912, E. P. Meinecke (Type).

64. *Taphrina crataegi* Sadebeck

Taphrina crataegi Sadebeck, Jahrb. Hamburg. Wissensch. Anst. **8**:61-95. 1890.
Exoascus bullatus (Berk.) Fkl., in part. Sadebeck, Jahrb. Hamburg. Wissensch. Anst. **1**:93-124. 1884.
Exoascus crataegi Sadebeck, Jahrb. Hamburg. Wissensch. Anst. **10**:5-110. 1893.

Causing leaf-curl and deforming shoots (not causing true witches' brooms) of *Crataegus monogyna* Jacz., *C. oxyacantha* L., *C. sanguinea* Pall.

Mycelium intercellular.

Asci hypophyllous, cylindric, rounded or truncate at the apex, with stalk cell; ascospores eight, round, ovate, or elliptic, frequently budding in the ascus. (Fig. 27, E.)

Dimensions: Of *asci*, 20-36μ × 8-12μ; of *stalk cells*, 6-13μ × 6-13μ; of *ascospores*, 4-5.5μ × 3.5-4.5μ.

Distribution: Europe.

Material examined: C. monogyna. AUSTRIA: Wienerwald, Hühnerberg near Baden, May, 1904, Höhnel (Rehm, Asco. 1612). POLAND: Krakow, Raciborski (Ex. herb. A. Wróblewski).

C. oxyacantha. GERMANY: Mecklenberg, Kluschenberg near Stargard, June 5, 1907, P. Sydow (Myc. Ger. 593); Saxony, near Leipzig, May, 1884, Pazschke and Winter (Rab.-Wint. F. Eur. 3057.). POLAND: Fredrów, June 20, 1920, A. Wróblewski (Ex. herb. A. Wróblewski).

C. sanguinea. RUSSIA: Smolensk, 1896, A. Jaczewski (Herb. Inst. Prot. Plant Sect. Phytopath. Leningrad).

This fungus, included in *Taphrina bullata* by Fuckel (1873-4), was separated from that form by Sadebeck (1890).

65. *Taphrina potentillae* (Farl.) Johanson

Taphrina potentillae (Farl.) Johanson, Ofvers, K. Svensk. Vetensk. Akad. Forhandl. **1885**:29-47. 1886.
Exoascus deformans (Berk.) Fkl. var. *potentillae* Farlow, N. A. F. 299. Described by Farlow, Proc. Amer. Acad. Arts and Sci. **18**:65-85. 1883.
Taphrina tormentillae Rostrup, Bot. Tidsskr. **14**:230-243. 1885.
Magnusiella potentillae (Farl.) Sadebeck, Jahrb. Hamburg. Wissensch. Anst. **10**:5-110. 1893.

Causing small, whitish to yellowish thickened areas on leaves and stems of *Geum montanum* L., *Potentilla arguta* Pursh., *P. canadensis* L., *P. corsica* Lebem., *P. flabellifolia* Hook., *P. geoides* L., *P. glandulosa* L., *P. recta* L., *P. rupestris* L., *P. silvestris* Neck., *P. tormentilla* Schrk., *P. silvestris* Neck. × *P. procumbens* Sibth., *Potentilla* sp.

Mycelium intercellular.

Asci amphigenous, formed beneath epidermis, clavate, rounded or truncate at the apex, arising from the ends of intercellular hyphae as though borne on a pedicel; ascospores eight, round, ovate, or elliptic, usually budding in the ascus (Fig. 27, F.)

Dimensions: Of *asci*, 17-58μ × 7-17μ; of *ascospores*, 4-5.5μ × 3-4.5μ.

Distribution: Europe, eastern North America.

Material examined: Geum montanum. Corsica: Monte Rotondo, July 22, 1902, R. Maire (Ex. Herb. R. M.).

Potentilla arguta. Connecticut: West Haven, July, 1890, R. Thaxter (Rel. Farl. 644). Michigan: East Lansing, June 29, 1943, E. A. Bessey. Sweden: Uppsala, June 17, 1907, O. Juel.

P. canadensis. Connecticut: New Haven, June 27, 1928, G. P. Clinton; *ibid.*, June 30, 1928, A. J. M. Massachusetts: Wellesley, June 8, 1935, D. H. Linder; *ibid.*, June 22, 1935, *id.* New Jersey: Newfield, Aug., 1894 (F. Columb. 408). Ohio: Warren Co., Foster, May 15, 1937, W. B. Cooke. Tennessee: Elkmont, June 8, 1937, L. R. Hesler. Vermont: Griffith Shelter, Aug. 10, 1936, R. H. Thompson.

P. corsica. Corsica: Coscione near Grienza, June 7, 1901, R. Maire (ex. herb. R. Maire).

P. flabellifolia. California: Mt. Shasta, South Gate Springs, July 10, 1947, Wm. Bridge Cooke (Herb. W. B. C. 20282).

P. geoides. Sweden: Uppsala, Bot. Gard., June 17, 1907, O. Juel; *ibid.*, June 16, 1916, *id.*

P. glandulosa. California: Mt. Shasta, July 5, 1940, W. B. Cooke (Herb. W. B. C. 14626).

P. recta. Sweden: Glanshammar, Skäfsund, Aug. 21, 1925, T. Vestergren.

P. rupestris. GERMANY: Bavaria, Kappellenwiese, near Gerolzhofen, Sept. 17, 1915, A. Vill. (Myc. Ger. 1957). NORWAY: Oslo, Bot. Gard., Aug. 24, 1931, I. Jørstad.

P. silvestris. GERMANY: Brandenburg, Prignitz, Triglitz, Sept. 29, 1898, O. Jaap (F. Sel. Exs. 7). POLAND: Krakow, Raciborski (Ex. herb. A. Wróblewski).

P. procumbens × *silvestris.* GERMANY: Schleswig-Holstein, Föhr. Is., Nieblum, Aug. 1, 1904, O. Jaap (F. Sel. Exs. 7b).

Potentilla sp. (cultiv.). CALIFORNIA: Berkeley, March, 1940, H. N. Hansen.

HOST INDEX TO SPECIES OF *TAPHRINA* ON ROSACEAE, EXCLUSIVE OF *PRUNUS*

Amelanchier alnifolia Nutt.
Taphrina amelanchieri Mix
Crataegus monogyna Jacz.
Taphrina crataegi Sadeb.
Crataegus oxyacantha L.
Taphrina crataegi Sadeb.
Crataegus sanguinea Pall.
Taphrina crataegi Sadeb.
Geum montanum L.
Taphrina potentillae (Farl.) Johans.
Potentilla arguta Pursh.
Taphrina potentillae (Farl.) Johans.
Potentilla canadensis L.
Taphrina potentillae (Farl.) Johans.
Potentilla corsica Lebem.
Taphrina potentillae (Farl.) Johans.
Potentilla flabellifolia Hook.
Taphrina potentillae (Farl.) Johans.
Potentilla geoides L.
Taphrina potentillae (Farl.) Johans.
Potentilla glandulosa L.
Taphrina potentillae (Farl.) Johans.
Potentilla recta L.
Taphrina potentillae (Farl.) Johans.
Potentilla rupestris L.
Taphrina potentillae (Farl.) Johans.
Potentilla silvestris Neck.
Taphrina potentillae (Farl.) Johans.
Potentilla tormentilla Schrk.
Taphrina potentillae (Farl.) Johans.
Pyrus amygdaliformis Vill.
Taphrina bullata (Berk.) Tul.
Pyrus betulifolia Bunge
Taphrina bullata (Berk.) Tul.
Pyrus communis L.
Taphrina bullata (Berk.) Tul.
Pyrus lindleyi Rehd.
Taphrina bullata (Berk.) Tul.
Taphrina orientalis Mix
Sorbus alnifolia K. Koch.
Taphrina piri Kus.
Sorbus torminalis (L.) Crantz.
Taphrina sorbi (Jacz.) Mix

VI. SPECIES ON ROSACEAE

Form on plums: Prunus

66. *Taphrina pruni* Tulasne

Taphrina pruni Tulasne, Ann. Sci. Nat. 5 Ser. Botanique. **5**:122-136. 1866.
Exoascus pruni Fuckel, Jahrb. Nassau Ver. f. Naturk **23** and **24**:1-459. 1869 and 1870.
T. rostrupiana (Sadeb.) Giesenhagen, Flora **81**:267-361. 1895.
E. rostrupianus Sadebeck, Jahrb. Hamburg. Wissensch. Anst. **10**:5-110. 1893.
T. insititiae (Sadeb.) Johanson, Ofvers K. Svensk. Vetensk. Akad. Forhandl. **1885**:29-47. 1886.
E. insititiae Sadebeck, Jahrb. Hamburg. Wissensch. Anst. **1**:93-124. 1884.
T. pruni Tul. var. *divaricata* Jaczewski, Pocket Key for the determination of fungi, Part I. Exoascales, Leningrad. 1926.

Causing deformed fruits ("bladder-plums," "plum pockets") and thickened malformed twigs often bearing curled leaves on *Prunus cerasifera* Ehrh. var. *divaricata* Bailey, *P. domestica* L., *P. insititia* L., *P. spinosa* L., *P. ussuriensis* Koval. and Kost.

Mycelium intercellular.

Asci cylindric-clavate, rounded or truncate at the apex; stalk cell present, sometimes nearly half the length of the ascus. Ascospores eight, round, ovate, or elliptic, commonly budding in the ascus. (Fig. 28, A-F.)

Dimensions: Of *asci*, 17-53μ × 5-17μ; of *stalk cells*, 5-27μ × 4-13μ; of *ascospores*, 4-7μ × 3-6μ.

Distribution: Europe. Japan. (North America?)

Material examined: Prunus cerasifera var. *divaricata.* Russia: Caucasus, Suchum, April 27, 1914, W. Siemaszko; Transcaspia, Kopet-Dagh, Han Ailaion, May 30, 1924, Czerniakowska (det. Jaczewski).

P. domestica. New Jersey: (slide in Atkinson collection). New York: Geneva, July 9, 1935, F. C. Stewart. Manitoba: Winnipeg, July 1, 1935, G. R. Bisby. Japan: Iwate, Tamayama, May 29, 1908, G. Yamada (Herb. Morioka Imp. Coll. Agric. and For.). Sweden: Bohuslän, Ljings, Korskviken, July 15, 1888, A. G. Eliasson; Skåne, Bunkeflo, June 10, 1884, Eriksson (on shoots), Småland, Uråsa, Skye, June 3, 1883, Johanson (on shoots); Södermanland, Allhelgona, Bullersta, June, 1894, G. V. Schotte.

P. insititia (as *Taphrina insititiae*). Denmark: Sjaelland, Kallehave, May 14, 1913, J. Lind (Micr. Rar. Sel. 1744). Germany: Brandenburg, Triglitz in Prignitz, May 22, 1899, O. Jaap (F. Sel. Exs. 51). Hungary: Leutschovia, Locse, June, 1891, V. Greschik (F. Leutschov.).

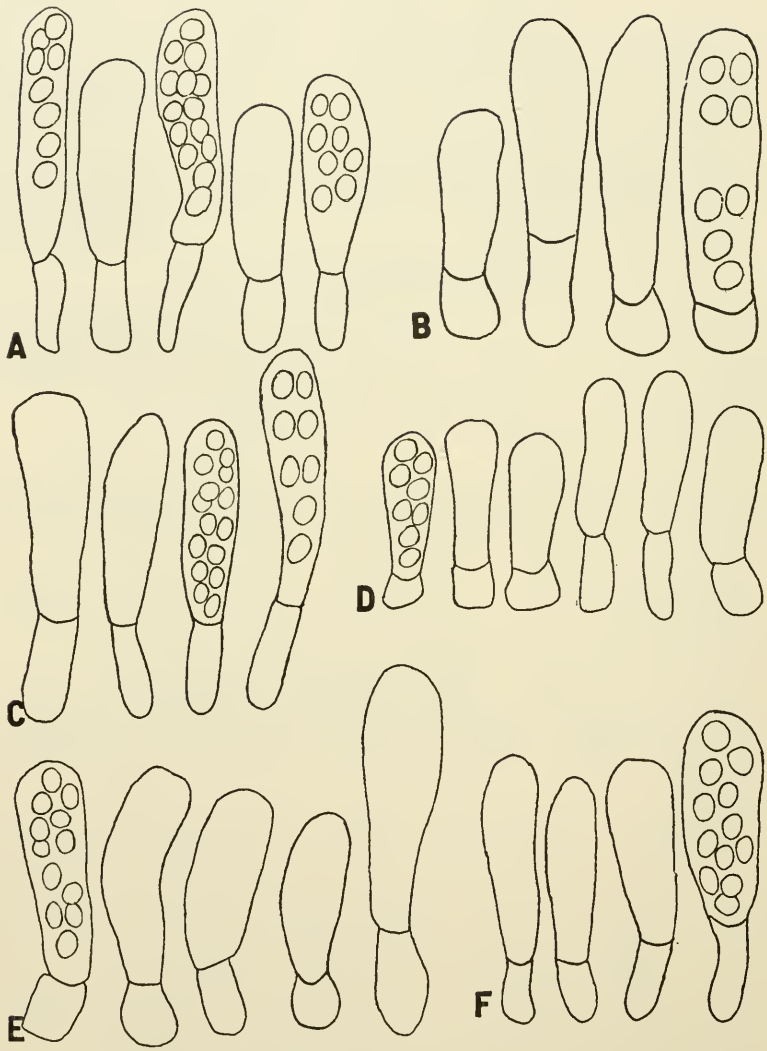

FIG. 28. Asci (×900) of *Taphrina pruni*. A, on *Prunus domestica;* B, *P. cerasifera* var. *divaricata;* C, *P. ussuriensis;* D, *P. domestica,* twigs (as *T. insititiae*); E, *P. spinosa,* twigs; F, *P. spinosa,* fruits (E, F, as *T. rostrupiana*).

P. spinosa (as *T. rostrupiana*). Dalmatia: Cattara, April, 1914, O. Jaap (Ex. herb. Sydow, on both fruits and shoots). Italy: Florence, Vallombrosa, spring 1898, F. Cavara (Myc. Ital. 537). Poland: Pulawy, May, 1923, W. Konopacka (Herb. Inst. Phytopath. Schol. Sup. Varsaviensis). Russia: Nowotscherkassk, May 2, 1911, O. Trebu (shoots). Sweden: Skåne, Kullen, Arild, July 26, 1923, O. Juel (fruits and shoots).

P. ussuriensis. Russia: Nicolsk-Ussurisk, July, 1912, N. Naumov (Herb. Inst. Prot. Plant. Sect. Phytopath. Leningrad).

A portion of a specimen received from R. Maire, labelled: "*Taphrina insititiae*, Graecia, in *Pruno pseudo-armeniaca*, in planitie Kardianos Kambros monelato-vorno inter Lidiki et Amphissam. Balais de sorceres efformat. 14/8 R. Maire" (Miss. Bot. Orient. 1906. 268) was insufficient to allow determination of any fungus present.

Reduction of these various species to synonymy is based on the belief (borne out by observation of several other species of *Taphrina*) that morphologically similar fungi on the fruits and leaves of the same host must be the same. Further there is no clear morphological distinction between different host-forms. The dimensions of the various fungi, considered as separate species, are as follows:

	Asci	*Stalk cells*
T. pruni on fruits of *P. domestica*	23-53μ × 5-13μ	11-27μ × 5-10μ
T. pruni on fruits of *P. cerasifera* var. *divaricata*	26-53μ × 10-17μ	8-23μ × 8-12μ
T. insititiae on shoots of *P. domestica*	17-33μ × 5-10μ	5-10μ × 4-13μ
T. insititiae on shoots of *P. insititia*	17-33μ × 5-10μ	5-10μ × 4-13μ
T. rostrupiana on fruits of *P. spinosa*	26-53μ × 8-16μ	8-20μ × 5-13μ
T. rostrupiana on shoots of *P. spinosa*	23-33μ × 7- 8μ	7-12μ × 6- 8μ

Taphrina insititiae has shorter asci and shorter, and more nearly cuboidal stalk cells (often wider than high) than *T. pruni*. This is the same sort of difference observed in other pruniculous species between the asci formed on fruits and those on leaves. The same difference is to be observed in *Taphrina rostrupiana*, which has been considered to be the same fungus whether occurring on fruits or leaves. There is fairly good agreement in ascus-size between the three fungi under consideration when occurring on fruits.

The frequently noted occurrence of one of these fungi on fruits

only or on shoots only can be explained by the fact that conditions necessary to infection of both fruits and shoots may not occur every season. Magnus (1894) finding plum pockets and malformed shoots on the same tree of *Prunus domestica,* and finding no distinction between the asci from both sources suggested that the same fungus (*T. pruni*) was present on both fruits and twigs.

67. *Taphrina communis* (Sadeb.) Giesenhagen

Taphrina communis (Sadeb.) Giesenhagen, Flora **81**:267-361. 1895.
Exoascus communis Sadebeck, Jahrb. Hamburg. Wissensch. Anst. **10**:5-110. 1893.
T. longpipes (Atk.) Giesenhagen, l.c.
E. longpipes Atkinson, Bull. Torr. Bot. Club. **21**:372-380. 1894.
T. decipiens (Atk.) Giesenhagen, l.c.
E. decipiens Atkinson, l.c.
T. rhizipes (Atk.) Giesenhagen, l.c.
E. rhizipes Atkinson, l.c.
E. decipiens Atk. var. *superficialis* Atkinson, l.c.
T. mirabilis (Atk.) Giesenhagen, l.c.
E. mirabilis Atkinson, l.c.
E. mirabilis Atk. var. *tortilis* Atkinson, l.c.

Causing deformation of fruits ("bladder plums," "plum pockets") and of twigs, sometimes with curling of leaves (not witches' brooms) of *Prunus americana* Marsh., *P. angustifolia* Marsh., *P. hortulana* Bailey, *P. hortulana* Bailey var. *mineri* Bailey, *P. lanata* (Sudw.) Mack. and Bush, *P. maritima* Marsh., *P. munsoniana* Wight and Hedr., *P. nigra* Ait., *P. salicina* Lindl., *P. umbellata* Ell.

Mycelium intercellular.

Asci cylindric-clavate, usually rounded at the apex, stalk cell narrower than the ascus, of variable length, ascospores eight, round, ovate, or elliptic, frequently budding in the ascus.

Dimensions: Of *asci,* 27-83μ × 5-13μ; of *stalk cells,* 6-56μ × 3-12μ; of *ascospores,* 4-7μ × 3.5-5.5μ.

Frequently longer asci occur, projecting above the general surface of the hymenium; these are approximately twice the length of neighboring asci. Such long asci (which are normal in all other respects) may reach a length of 116μ. (Fig. 29, A-F, Fig. 30, A-E.)

Distribution: eastern and middle North America.

Material examined: Prunus americana. ARKANSAS: Conway, May 1, 1939, T. Jones; Fly Gap (near Cass), May 12, 1940, V. H. Young, Mountainburg, May 24, 1941, A. J. M. IOWA: (slides, Atkinson Collection, one on variety Cheney). KANSAS: Abilene, May 22, 1926, H. W. King; Baldwin, May, 1926, A. J. M.; *ibid.,* numerous collections 1925-1939, *id.;* Belpre, June 9, 1924, R. P. White; Lawrence, May 23, 1939, R. Sailer; *ibid.,* K. U. Campus, May, 1942,

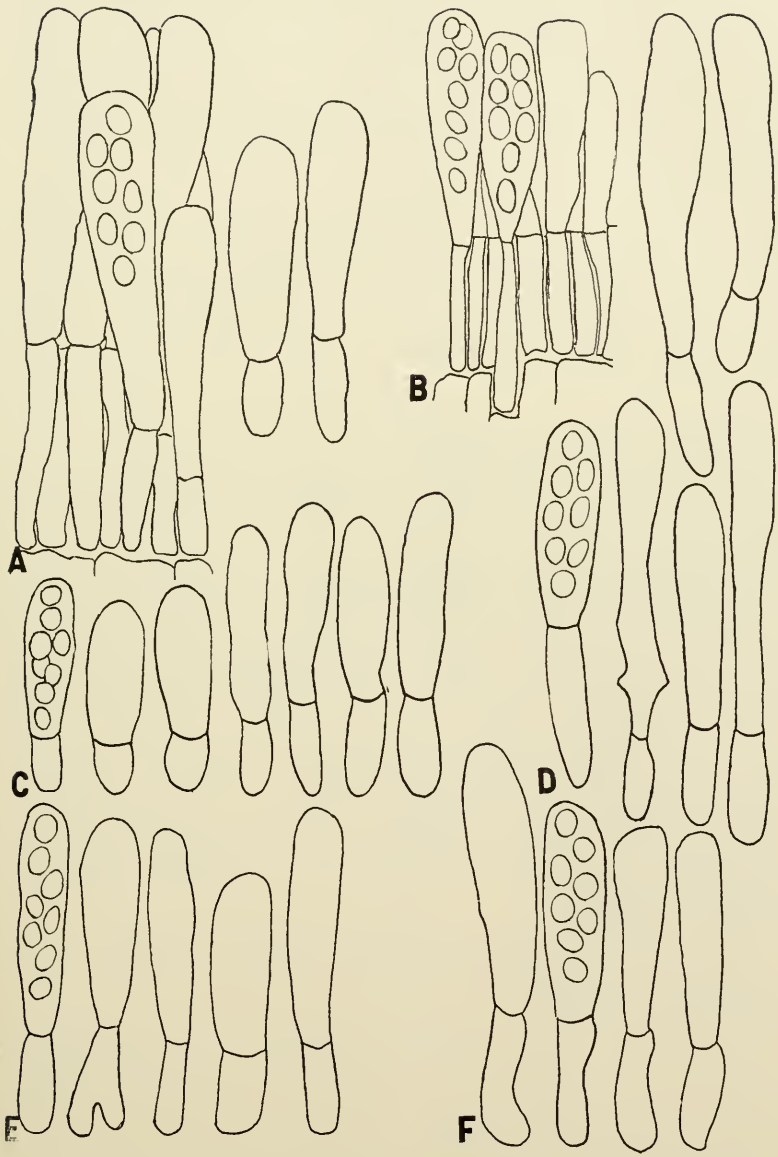

Fig. 29. Asci (× 900) of *Taphrina communis*. A, on *Prunus americana* (fruits); B, *P. umbellata;* C, *P. americana* (twigs); D, *P. maritima* (fruits); E, *P. munsoniana;* F, *P. nigra.*

A. J. M.; Rockport, June, 1894, E. Bartholomew (N. A. F. 298); Rooks Co., May 24, 1901, E. Bartholomew (F. Columb. 1533). MASSACHUSETTS: Morden, June 27, 1929, I. L. Conners. MICHIGAN: Alma, June 2, 1894 (slide in Atkinson Collection); Forest Lake, June 18, 1935, O. J. Eide. NEW YORK: Ithaca, Ellis Hollow Road, June 10, 1940, A. J. M.; *ibid.*, June 22, 1940, *id.* (fruits and shoots); locality not given (slide in Atkinson Collection, on Baldwin variety).

As *T. decipiens.* KANSAS: Baldwin, May, 1927, A. J. M.; Stockton, June 1, 1903, E. Bartholomew (F. Columb. 1927). NEW YORK: Aetna, July 6, 1894 (slide in Atkinson Collection). NORTH CAROLINA: Raleigh, May, 1936, R. F. Poole. SASKATCHEWAN: Indian Head, Aug. 5, 1926, P. M. Simmonds (Herb. Central Expt. Farms. 149).

As *T. decipiens* var. *superficialis.* NEW YORK: Aetna, July 6, 1894 (slide in Atkinson Collection).

As *T. longpipes.* MISSISSIPPI: Grand Rapids, 1898, E. J. Coler (Farl. Herb.). NEW YORK: Danby (slide in Atkinson Collection, from type material).

P. angustifolia, as *T. mirabilis.* ALABAMA: April 28, 1892 (slides in Atkinson Collection); Auburn, April-May, 1890-1892, G. F. Atkinson (Econ. F. 729). ARKANSAS: Fayetteville, May, 1940, V. H. Young; Hamburg, May, 1939, J. C. Dunegan (fruits and shoots). FLORIDA: Gainesville, March 26, 1936, G. F. Weber; *ibid.,* April 9, 1941, *id.* GEORGIA: Athens, May 14, 1936, J. H. Miller. IOWA: Chicasa Co. (slide in Atkinson Collection). KANSAS: 1924, R. P. White; Lawrence, June, 1923, A. J. M.; *ibid.,* several coll. subsequent years, *id.* MISSISSIPPI: Morse, May 21, 1936, L. E. Miles. TENNESSEE: Elkmont, June 13, 1937, L. R. Hesler. VIRGINIA: 1935, S. A. Wingard.

As *T. mirabilis* var. *tortilis.* ALABAMA: (slide in Atkinson Collection). FLORIDA: Gainesville, March 26, 1936, G. F. Weber. KANSAS: 1924, R. P. White.

P. hortulana, as *T. mirabilis.* ARKANSAS: Bentonville, June, 1907, W. A. Scott (Herb. Cornell Univ. 3502). IOWA: Cedar Rapids (slide in Atkinson Collection). WISCONSIN: Blue River, June 9, 1932, J. J. Davis (Farl. Herb.).

P. hortulana var. *mineri.* IOWA: 1894, A. Noe (slide in Atkinson collection).

P. lanata. ARKANSAS: Conway, May 1, 1939, T. Jones.

P. maritima. MASSACHUSETTS: (slide in Atkinson Collection,

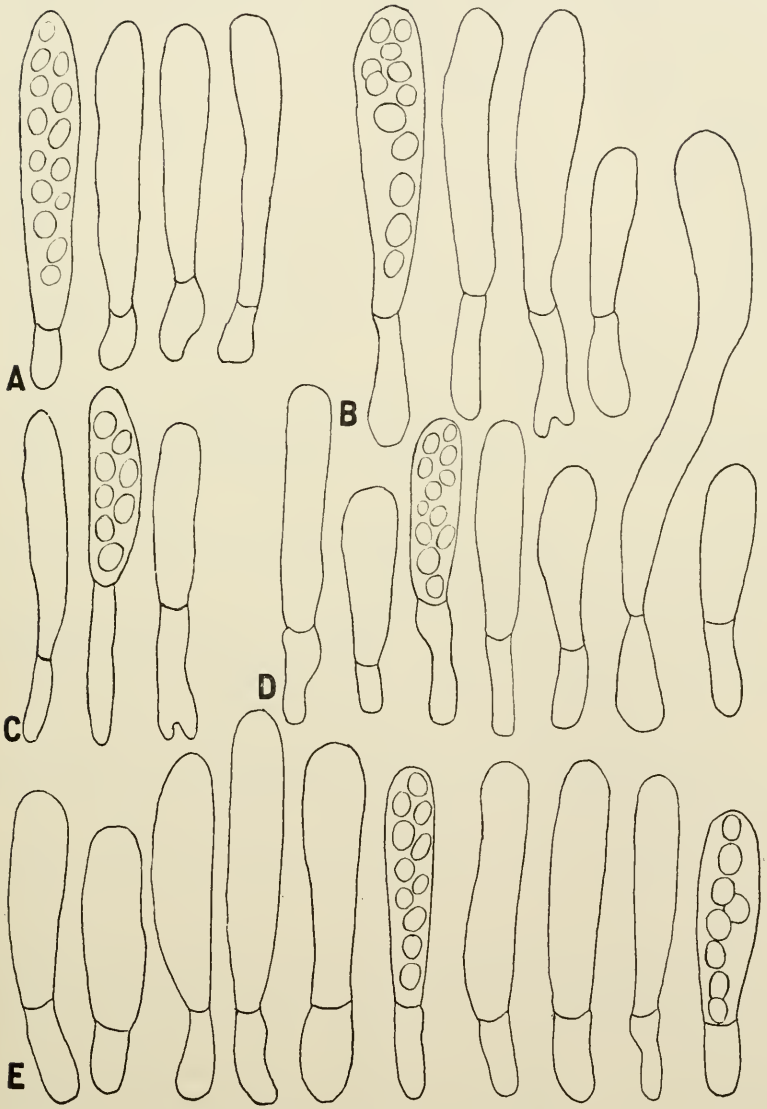

Fig. 30. Asci (× 900) of *Taphrina communis*. A, on *Prunus maritima* (twigs); B, *P. americana* (*T. rhizipes*); C, *P. americana* (*T. longipes*); D, *P. angustifolia* (*T. mirabilis*); E, *P. angustifolia* (*T. mirabilis* var. *tortilis*).

fruits); Barnstable, July 13, 1939, O. C. Boyd (fruits); Cape Cod, June 13, 1939, W. H. Thies and B. Tomlinson (fruits and shoots); Falmouth, June 22, 1940, R. H. Thompson (fruits and shoots); West Falmouth, June 19, 1911, A. B. Seymour (fruits).

P. munsoniana. (Cornell Univ. Herb. 4849, preserved in formalin).

P. nigra. MICHIGAN: St. Johns, June 20, 1938, E. A. Bessey. NEW YORK: Ithaca, Highland Road, June 7, 1940, A. J. Eames; Kline Road, near cemetery, June 7, 1940, A. J. M.; *ibid.*, June 8, 1940, *id.;* Loon Lake, July, 1940, J. R. Stickney. ONTARIO: east of Wilcox Lake, June 14, 1936, R. F. Cain (Herb. Univ. Toronto, 19047). QUEBEC: Aylmer, June 24, 1937, R. K. Eden (Herb. Central Expt. Farms 4614).

P. salicina. ALABAMA: Auburn, May 1, 1892, G. F. Atkinson (apparently type of *T. rhizipes,* both fruit and shoot affected); *ibid.,* May 8, 1892, *id.* (three slides in Atkinson Collection). CONNECTICUT: Cheshire, June, 1891, R. Thaxter (Herb. R. Thaxter 1497).

P. umbellata. GEORGIA: Stone Mountain, April 26, 1925, J. H. Miller (Herb. Univ. Georgia 2475).

As far as Sadebeck (1893) distinguished between *Taphrina communis* and *T. pruni* the former had slightly smaller asci and a longer and narrower stalk cell. Sadebeck's measurements are:

T. pruni, asci 40-55μ × 8-15μ,stalk cells 10-16μ × 8μ.

T. communis, asci 30-40μ × 8μ, stalk cells 15-20μ × 3-5μ.

Actually *T. communis* has longer and slightly more slender asci and stalk cells, the dimensions of the two species being as follows:

T. pruni, asci 17-53μ × 7-17μ, stalk cells 5-27μ × 4-13μ.

T. communis, asci 27-83(116)μ × 5-13μ, stalk cells 7-56μ × 4-10μ.

The chief distinguishing feature of *T. communis* is the occasional occurrence (mentioned above) of very long asci (as long as 116μ). This was observed by Robinson (1887) who spoke of it as "dimorphism," describing long, slender, usually eight-spored asci, 43-60μ × 5-7μ; and shorter, thicker, usually many-spored asci, 27-35μ × 9-12μ. Robinson also states that he found the asci of his "*T. pruni*" more slender than those described by Sadebeck. Although the host is given as *P. domestica* it is apparent that Robinson was dealing with *Taphrina communis.* If his host-determination and those of others who have reported plum pockets on *P. domestica* in North America, are correct it means that *P. domestica* is attacked

by *T. communis*. Apparently it is not highly susceptible. "Domestica" plums are chiefly cultivated in the eastern United States. Plum pockets on cultivated plums have been less commonly reported from that area than from the Mississippi Valley where "Americana" varieties are grown. Assuming that *Taphrina pruni* and *T. communis* are separate species it may be doubted that the former occurs in North America. Plum pockets found on "Domestica" plums in this country should be ascribed to *Taphrina communis*.

The long asci are quite as common in the form described by Atkinson as *Exoascus mirabilis* as in *Taphrina communis* (in the narrower sense). Indeed the former fungus cannot in any way be distinguished from *T. communis*. It deforms shoots of *Prunus angustifolia* and only rarely attacks fruits. This may be due to a less degree of susceptibility of the fruits, or to rarity of conditions necessary for fruit infection. In eastern Kansas, *Prunus angustifolia* seldom bears fruit.

That the fungus on shoots and fruits of *P. angustifolia* are one and the same became clear from a study of the material collected by J. C. Dunegan at Hamburg, Arkansas. The asci were similar on both host organs, those from fruits measuring 33-50μ × 7-10μ with stalk cells 13-23μ × 5-8μ, while asci from shoots were 30-46μ × 7-10μ, stalk cells 13-20μ × 5-8μ. (As in other species asci on shoots are slightly smaller than those on fruits.)

The case for synonymy of *Taphrina communis* and *T. decipiens* has been well presented by Ray (1939) who calls attention to the fact that asci borne on the leaves of infected shoots are somewhat smaller than those found on fruits. Shoot infection is, at least in some localities, less common than fruit infection. In the periods 1926-1929 and 1931-1939 a stand of *Prunus americana* at Baldwin, Kansas, was visited annually. Plum pockets occurred every season but deformed shoots in 1927 only.[7] It is difficult to believe that this single occurrence of malformed shoots in this isolated plum thicket was due to a separate fungus. On the other hand, the idea that conditions favoring shoot infection by the fungus (*T. communis*) known to be present, may occur but rarely is entirely credible. In the more humid climate of the eastern United States (Ithaca, New York, for example) shoot infection seems to be common.

7. The plum thicket in question was not visited for several years after 1939, but in 1947, an unusually rainy spring, shoot infections (as well as pockets) were observed to be abundant in all trees. Deformed fruits and shoots were also observed near Lecompton, Kansas, on May 15, 1947, by R. L. McGregor.

Atkinson (1894) distinguished two other pocket-forming species from *Taphrina communis*, namely: *Exoascus longipes*, and *E. rhizipes*. The first of these was characterized by an unusually long stalk cell. Asci of *T. communis* with stalk cells as long (35μ) as those described by Atkinson for *E. longipes*, are fairly common and have been found in many collections. Because of the variability of *Taphrina communis* from fruit to fruit of the same collection it would be impossible to sort out the various specimens studied into *T. communis* and "*T. longipes*."

Atkinson's *Exoascus rhizipes*, occurring on Japan plum, was characterized by rhizoidal extensions of the lower end of the stalk cell. Such rhizoidal processes occasionally occur in *Taphrina communis* on various hosts and are no more abundant in Atkinson's type material of *E. rhizipes* than in many other collections.

68. *Taphrina pruni-subcordatae* (Zeller) Mix

Taphrina pruni-subcordatae (Zeller) Mix, Univ. of Kansas Sci. Bull. **24**:10: 151-176. 1936.
Exoascus pruni-subcordatae Zeller, Mycologia **19**:130-143. 1927.

Causing deformed fruits (plum pockets) and thickened, malformed shoots on *Prunus subcordata* Benth.

Mycelium intercellular.

Asci clavate, rounded or truncate at the apex, provided with a stalk cell, ascospores eight, round, ovate, or elliptic, often budding in the ascus (Fig. 31, A, B).

Dimensions: Of *asci*, 33-73μ × 7-12μ; of *stalk cells*, 7-40μ × 5-12μ; of *ascospores*, 4-7μ × 3.5-6μ.

Distribution: Rocky-Mountain and Pacific-Coast areas, North America.

Material examined: CALIFORNIA: Cordelia, April 22, 1936, H. Earl Thomas (fruits); Elk Creek, May 15, 1938, *id.* (fruits); *ibid.* (a few miles distant), May 15, 1938, *id.* (shoots); Mt. Shasta, Sept. 6, 1940, W. B. Cooke (Herb. W. B. C. 14724, shoots); Taylorsville, April 23, 1915, J. S. Boyce (Herb. J. S. B. 285, shoots). COLORADO: Boulder, 1942, A. J. M. (fruits and shoots); Fort Collins, 1935, L. W. Durrell (fruits).

This species is closely related to *Taphrina communis*. Its asci are usually somewhat longer and wider and the stalk cells a little shorter than in that species. The exceptionally long occasional asci characteristic of *T. communis* are absent.

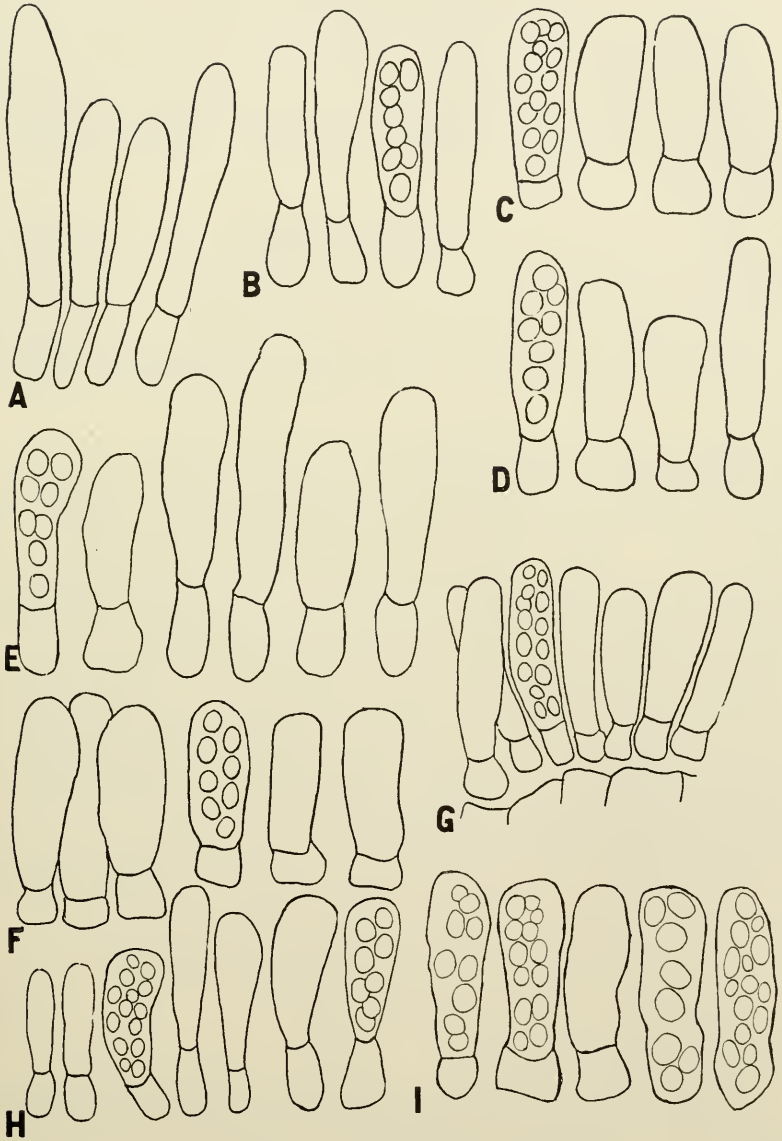

Fig. 31. Asci (× 900) of A, B, *T. pruni-subcordatae* (A, on fruits; B, on twigs); C, D, *T. mume;* E, *T. deformans* on *Prunus communis;* F, G, *T. deformans* on *P. persica;* H, *T. mexicana;* I, *T. armeniacae.*

Forms on Apricots

69. *Taphrina mume* Nishida

Taphrina mume Nishida, Miyabe Festschrift Tokyo, 1911.
Taphrina deformans (Berk.) Fkl. var. *armeniaca* Ikeno, Flora **92**:1-31. 1903.

Causing leaf-curl and hypertrophy of twigs of *Prunus armeniaca* L. var. *ansu* Maxim., *P. mandshurica* Koehne, and *P. mume* Sieb. and Zucc.

Mycelium intercellular.

Asci amphigenous or hypophyllous, cylindric, rounded or truncate at the apex, with a broad, short stalk cell; ascospores eight, round, ovate, or elliptic. (Fig. 31, C, D.)

Dimensions: Of *asci,* 20-33μ × 8-13μ (23-52μ × 8-15μ according to Nishida); of *stalk cells,* 7-15μ × 5-15μ; of *ascospores,* 4-6μ × 3-5μ.

Distribution: China, Japan.

Material examined: P. armeniaca. JAPAN: Fukui, Togo-mura, May 18, 1922, T. Toyoda (Herb. Morioka Imp. Coll. Agric. and For.)

P. mume. JAPAN: Hiroshima, May 7, 1930, S. Kusano; Iwate, Morioka, June 23, 1927, K. Togashi (Herb. Morioka Imp. Coll. Agric. and For.); *ibid.,* June 17, 1930, G. Yamada *id.*

This species was considered by Ikeno (1903) and also by Tai (1937) to be a variety of *Taphrina deformans.* It obviously is closely related to *Taphrina deformans,* and if Nishida's measurements are correct, is not morphologically distinguishable from that fungus. Though it is probably identical with *T. deformans,* it is retained as a separate species pending further study.

The occurrence of *Taphrina mume* on *Prunus mandshurica* is reported by Tai. No specimen has been seen by the writer.

70. *Taphrina armeniacae* Georgescu and Badea

Taphrina armeniacae Georgescu and Badea, Analele Institului de Cercetări si Experimentatie Forestură **3**:162-167. 1938.

Causing witches' brooms on *Prunus armeniaca* L.

Mycelium intercellular.

Asci amphigenous, cylindric-clavate, rounded or truncate at the apex, a stalk cell usually present but occasionally absent; ascospores eight, round, ovate or elliptic.

Dimensions: Of *asci,* 22-29μ × 7-10μ; of *stalk cells,* 7-10μ × 7-13μ; of *asci lacking stalk cells,* 29-38μ × 8-10μ; of *ascospores,* 4-7μ × 4-6μ. (Fig. 31, I.)

Distribution: Rumania.

Material examined: Twigs and leaves preserved in alcohol, received June, 1947, from Botanical Laboratary, Polytechnic Institute, Bucharest.

Georgescu and Badea state that this fungus causes a witches' broom, with negatively geotropic curvature of twigs. The material studied may well have been from such a witches' broom, but this could not be determined with certainty. The affected leaves are not curled nor conspicuously thickened.

Georgescu and Badea also describe the asci as hypophyllous and lacking a stalk cell. In the material studied asci were regularly amphigenous, and all but a few asci possessed well defined stalk cells. Only by careful search could an occasional ascus lacking a stalk cell be found.

71. *Taphrina deformans* (Berk.) Tulasne

Taphrina deformans (Berk.) Tulasne, Ann. Sci. Nat. 5 Ser. Bot. **5**:122-136. 1866.
Exoascus deformans (Berk.) Fuckel, Jahrb. Nassau. Ver. Naturk. **23** and **24**:1-459. 1869 and 1870.
Ascomyces deformans Berkeley, Outl. Brit. Fungi. 1860.
Taphrina amygdali (Jacz.) Mix, Univ. Kansas Sci. Bull. **24**:**10**:151-176. 1936.
Exoascus amygdali: Jaczewski, Pocket Key for Determination of Fungi. Part I. Exoascales. Leningrad. 1926.

Causing leaf curl and malformation of twigs of *Prunus communis* Arcang. var. *amara Schneid.*, var. *dulcis* Schneid., and *P. persica* L.

Mycelium intercellular.

Asci epiphyllous, occasionally amphigenous, cylindric-clavate, rounded or truncate at the apex, provided with a stalk cell. Ascospores eight, round, ovate, or elliptic, frequently budding in the ascus. (Fig. 31, E, F, G.)

Dimensions: Of *asci*, 17-56μ × 7-15μ; of *stalk cells*, 6-20μ × 5-15μ; of *ascospores*, 3-7μ × 3-7μ.

Distribution: world wide, apparently coincident with that of its hosts.

Material examined: P. persica. California: Berkeley, May 17, 1935, Ruth F. Allen ("ornamental peach"); Palo Alto, April 21, 1939, R. H. Thompson (*P. persica* var. *plena*); *ibid.*, Stanford Univ. orchard, May 23, 1895, S. H. Burnham (nectarine). Illinois: Fayette Co., May 14, 1936, G. H. Boewe; Johnson Co., May 11, 1936, *id.* Kansas: Lawrence, numerous collections 1924-1939, A. J. M. Michigan: Ann Arbor, May 28, 1933, E. B. Mains (Herb. Univ. Michigan). North Carolina: May, 1936, R. F. Poole. Vir-

GINIA: Norfolk, May 6, 1936, H. T. Cook. ONTARIO: London, June, 1892, J. Dearness (F. Columb. 139). CHINA: Kwangsi, Long Ping (Ling Yuin Hsein), April 9, 1933, S. Y. Cheo (Herb. Univ. Nanking). ENGLAND: 1938 (material in alcohol from Royal Coll. of Sci., London). JAPAN: Iwate, Kadoma, June 15, 1931, K. Togashi (Herb. Morioka Imp. Coll. Agric. and For.); Morioka, College Orchard, July 1, 1931; K. Togashi *id.* POLAND: Pulawy, 1923, W. Konopacka (Herb. Inst. Phytopath. Scol. Sup. Agric. Varsaviensis).

P. communis. ENGLAND: specimens in alcohol received from Prof. W. Brown, Royal Coll. of Sci., London. RUSSIA: Caucasus, Derbent, June 10, 1930, A. S. Letov and L. S. Gutner (Herb. Inst. Prot. Plant. Sect. Phytopath. Leningrad). SCOTLAND: Aberdeen, June 19, 1939, Prof. Matthews; St. Andrews, July, 1938, J. A. Macdonald (in alcohol), *ibid.*, June 20, 1939, *id.*

The form on *Prunus communis,* whose occurrence was first recorded by Ráthay (1878), has usually been considered identical with *Taphrina deformans.* Campbell (1925) called it a variety of *T. deformans,* stating that its asci were without stalk cells. In this he was in error. The material received from J. A. Macdonald was collected at St. Andrews from the tree from which Campbell obtained his specimens. This material showed typical asci with stalk cells.

Jaczewski (l. c.) in describing *Exoascus amygdali* stated that it was different from Campbell's fungus (his statement being founded on Campbell's mistaken description). Jaczewski also stated that the asci were regularly hypophyllous. Jaczewski's type material was not obtainable but material that he had examined was received from K. Naumov. In these specimens asci were mostly epiphyllous but occasionally amphigenous.

Cultures were secured in 1939 from the specimens collected by Matthews at Aberdeen, and by Macdonald at St. Andrews. In both cases the material was received in London the day following its collection and isolations were made in the laboratory of Prof. W. Brown of the Royal College of Science.

Using these cultures inoculations of peach were made at Lawrence in the spring of 1947. The trees chosen had been planted in a campus nursery three years previously and had never shown any curl. They were sprayed with 1-50 formalin a few weeks before inoculation. On April 2 during a light rain, inoculum from agar cultures was smeared on opening buds. (Green tips were protrud-

ing about an eighth of an inch from these buds and natural infections of unsprayed trees in the neighborhood had undoubtedly occurred during a rainy period a few days earlier.) Several lower branches of one tree were inoculated with cultures from almond, those of another with cultures from peach. Severe curl resulted in both trees. It appeared later than natural curl on unsprayed trees and asci were not quite mature on May 20, though asci from natural curl had matured as early as May 10. Sprayed but uninoculated branches in the upper parts of these trees remained free from curl.

This indicates that the fungus on *Prunus communis* is not biologically distinct from the form on *P. persica* and that the former should not be distinguished from *Taphrina deformans* either as a separate species or as a variety.

72. *Taphrina mexicana* H. and P. Sydow

Taphrina mexicana H. and P. Sydow, Ann. Mycol. **18**:154-160. 1920.

Causing small witches' brooms on *Prunus microphylla* (HBK) Gray.

Mycelium intercellular.

Asci hypophyllous, clavate, rounded or truncate at the apex, stalk cell usually narrower than the ascus; ascospores eight, round, ovate, or elliptic, small, often budding in the ascus. (Fig. 31, H.)

Dimensions: Of *asci*, 22-30μ × 7-10μ; of *stalk cells*, 8-15μ × 6-8μ; of *ascospores*, 3.5-4μ × 2.5-3.5μ.

Distribution: Mexico.

Material examined: Mexico, 1913, C. Reiche (Bot. Mus. Berlin. Type).

Forms on Cherries: Microcerasus

73. *Taphrina cerasi-microcarpae* (Kuschke) Laubert

Taphrina cerasi-microcarpae (Kuschke) Laubert, in Sorauer, Handb. Pflanzenkr. **2**:457-499. 1928.
Exoascus cerasi-microcarpae Kuschke, Monit. Jard. Bot. Tiflis **31**:23-27. 1913.

Deforming fruits (causing "pockets") of *Prunus microcarpa* C. A. Mey., *P. tomentosa* Thunb. Perhaps also deforming twigs of *P. humilis* Bunge.

Mycelium intercellular.

Asci cylindric-clavate, rounded at the apex, provided with a stalk cell; ascospores eight, round, ovate, or elliptic, frequently budding in the ascus. (Fig. 32, A.)

Dimensions: Of *asci* (*P. microcarpa*), 35-50μ × 10-13μ (Kuschke),

(*P. tomentosa*) 26-46μ × 7-10μ (Mix); of *stalk cells* (*P. microcarpa*) "short" (Kuschke), 5-7μ long (Jaczewski 1926), (*P. tomentosa*) 8-13μ × 7-11μ (Mix); of *ascospores,* 5-7.5μ × 5-6.25μ.

Distribution: Caucasus, Japan, China.

Material examined: P. tomentosa. JAPAN: Ishikari, Hokkaido, June 30, 1902, G. Yamada (Herb. Morioka Imp. Coll. Agric. and For.).

Efforts to obtain a specimen of the fungus on *Prunus microcarpa* from Tiflis or from Leningrad were unsuccessful. It is not known whether a type specimen exists. Some specimens must have been available to Jaczewski (1926). Since the fungus has not been seen the description given above is taken from Kuschke (l. c.) and from Jaczewski (1926).

The fungus on *P. tomentosa* (called by its collector *T. pruni*) is placed here because of its similarity (except for somewhat narrower asci and longer stalk cells) and because the hosts are closely related. For the latter reason the fungus on *P. humilis* reported by Tai (1937) and called by him *Taphrina truncicola* is also tentatively assigned to *T. cerasi-microcarpae.*

74. *Taphrina flavorubra* Ray

Taphrina flavorubra Ray, Mycologia 31:56-75. 1939.

Causing smallish, elongated, pointed "plum pockets," and thickened deformed shoots on *P. besseyi* Bailey, *P. pumila* L., *P. pumila* L. var. *susquehanae* Jaeg.

Mycelium intercellular.

Asci cylindric-clavate, rounded at the apex, provided with a stalk cell; ascospores eight, round, ovate, or elliptic, frequently budding in the ascus. (Fig. 32, B, C).

Dimensions: Of *asci,* 20-53μ × 6-12μ; of *stalk cells,* 8-26μ × 4-10μ; of *ascospores,* 3-8μ × 2-5μ.

Distribution: North America.

Material examined: P. besseyi. KANSAS: Stockton, May 20, 1889, E. Bartholomew (N. A. F. 288). NEBRASKA: Eagle, May 13, 1941, R. W. Goss. OREGON: Corvallis, May 11, 1939, S. M. Zeller. PRINCE EDWARD ISLAND: Little York, Coolhead Road, Mrs. W. J. McDonald (Herb. Central Exp. Farms. 4610).

P. pumila. KANSAS: Rooks Co., 1893, E. Bartholomew (F. Columb. 924). MAINE: Fort Kent, July 1, 1904, M. L. Fernald (Maine Flora, Aroostook County). MICHIGAN: Arenas Co., July 20, 1938, E. A. Bessey. SOUTH DAKOTA: Brookings, June, 1893, Griffiths.

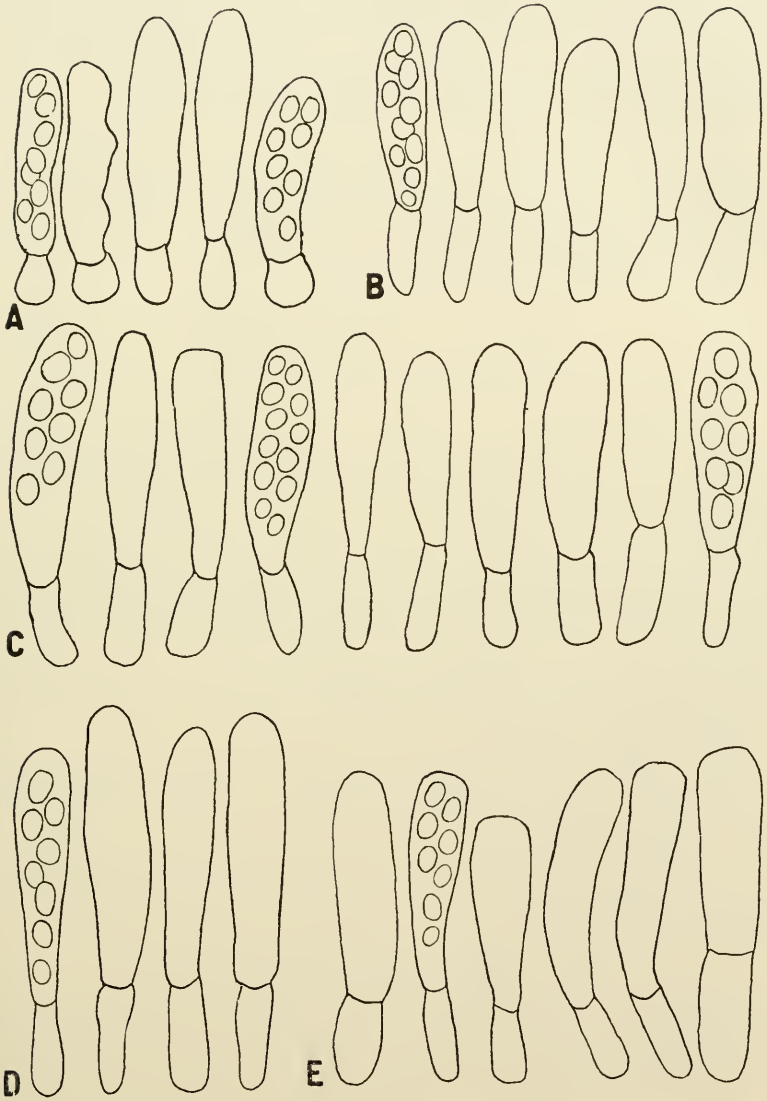

Fig. 32. Asci (× 900) of A, *Taphrina cerasi-microcarpae;* B, C, *T. flavorubra;* B, on *Prunus besseyi;* C, *P. pumila* var. *susquehanae;* D, E, *T. truncicola;* D, on *Prunus incisa;* E, *P. maximowiczii.*

P. pumila var. *susquehanae.* NEW YORK: Ithaca, South Hill Marsh, June 9, 1937, W. W. Ray (Herb. Dept. Plant Path. Cornell Univ. 26425. Fruits. Type); *ibid.,* June, 1940, A. J. M.; *ibid.,* June 1946, *id.* WISCONSIN: Millston, June 9, 1914, W. W. Davis; Necedah, June 9, 1917, *id.* (Herb. Marquette Univ.).

Ray (1939) described this species on *Prunus pumila* L. var. *susquehanae* (Willd.) Jaeg. The fungi on the closely related *P. pumila* L., and *P. besseyi* Bailey agree closely in morphology with *T. flavorubra,* and cause similar host-deformations. It seems proper to assign them to this species.

Forms on Cherries: Pseudocerasus, Lobopetalum, Eucerasus, Mahaleb, and *Phyllomahaleb*

75. *Taphrina truncicola* Kusano

Taphrina truncicola Kusano, Bot. Mag. Tokyo **19**:1-5. 1905.

Causing thickening and malformation of shoots (not witches' brooms) and deformation of inflorescenses of *Prunus incisa* Thunb., and *P. maximowiczii* Rupr.

Mycelium intercellular.

Asci cylindric-clavate, rounded at the apex, provided with a stalk cell. Ascospores eight, round, ovate, or elliptic, frequently budding in the ascus. (Fig. 32, D, E.)

Dimensions: Of *asci,* 30-45μ × 7-13μ; of *stalk cells,* 10-23μ × 5-12μ; of *ascospores,* 4.5-6.5μ × 4-5.5μ.

Distribution: Japan.

Material examined: P. incisa. JAPAN: Iwate, Mt. Iwate, June 18, 1908, G. Yamada (Herb. Morioka Imp. Coll. Agric. and For.); *ibid.,* June 4, 1919, *id.*

P. maximowiczii. JAPAN: Iwate, Mt. Iwate, June 14, 1919, F. Sawada (Herb. Morioka Imp. Coll. Agric. and For.); Nikko, June, 1900, T. Makino.

76. *Taphrina cerasi* (Fkl.) Sadebeck

Taphrina cerasi (Fkl.) Sadebeck, Jahrb. Hamburg. Wissensch. Anst. **8**:61-95. 1890.
Exoascus deformans f. *cerasi* Fuckel, Jahrb. Nassau. Ver. Naturk. **23** and **24**:1-459. 1869 and 1870.
E. cerasi (Fkl.) Sadebeck, Jahrb. Hamburg. Wissensch. Anst. **10**:5-110. 1893.
E. wiesneri Ráthay, Oesterreich Bot. Zeitschr. **30**:225. 1880. (No description.)
T. gilgii Hennings and Lindau, Hedwigia **32**:156-157. 1893.
T. minor Sadebeck, Jahrb. Hamburg. Wissensch. Anst. **8**:61-95. 1890.
E. minor Sadebeck, Jahrb. Hamburg. Wissensch. Anst. **10**:5-110. 1893.
T. pseudocerasi (Shirai) Saccardo, Sylloge Fungorum **14**:824.
Taphria pseudocerasi Shirai, Bot. Mag. Tokyo **9**:161-164. 1895.
E. pruni-acidae Jaczewski, Pockey Key for the determination of fungi. Part I. Exoascales. Leningrad. 1926.

Causing leaf curl (with only slight thickening) and witches' brooms on *Prunus avium* L., *P. cerasus* L., *P. cerasus* L. var. *frutescens* (Neilr.) Schneid. (*P. acida* K. Koch.), *P. fruticosa* Pall., *P. pennsylvanica* L., *P. pseudocerasus* Lindl., *P. serrulata* Lindl. var. *lannesiana* Rehd., and var. *spontanea* Wils., *P. yedoensis* Matsum.

Mycelium intercellular, perennial.

Asci hypophyllous, rarely amphigenous, clavate, rounded at the apex, provided with a stalk cell. Ascospores eight, round, ovate, or elliptic, often budding in the ascus. (Fig. 33, A-F.)

Dimensions: Of *asci*, 17-53μ × 5-15μ; of *stalk cells*, 5-26μ × 4-12μ; of *ascospores*, 3.5-9μ × 3-6μ.

Distribution: Europe, North America, Australia, New Zealand, South Africa, Japan.

Material examined: Prunus avium. California: Berkeley, June 6, 1935, H. Earl Thomas; Napa, April 21, 1929, *id.* New York: Ithaca, Coddington Road, May 27, 1937, W. W. Ray; near R. O. T. C. Stables, May 19, 1938, *id.; ibid.*, May 31, 1940, A. J. M. Oregon: Hood River, May 16, 1936, J. R. Kienholz; Polk Co., June 17, 1935, S. M. Zeller. Washington: Western Washington Exp. Sta. 1935. Czechoslovakia: Prenčŏw, Teplicky, June 20, 1890, A. Kmet (Fungi Schemnitz). England: Gloucestershire, Woodchester Park, May 13, 1934, E. M. Wakefield (Herb. Hort. Bot. Reg. Kew). Germany: Saxony, Putzkau, June 11, 1908, A. Schade (Myc. Germ. 798). Norway: Hordaland, Alsåker in Kinsarvik, June 5, 1929, I. Jørstad. Poland: Pulawy, June, 1923, Z. Czarnocka (Herb. Inst. Phytopath. Sch. Sup. Varsaviensis). Russia: Lublin, Nowo-Alexandria, June 1, 1910, H. Newodowski. Sweden: Uppland, Uppsala, June 2, 1895, A. G. Eliasson.

P. cerasus. British Columbia: Vancouver Island, Coutenay, June 8, 1941, W. S. Jones. Germany: Berlin, Grossbeeren, July, 1893, Lindau and Gilg (Herb. Sydow in Bot. Mus. Stockholm as "forma *Gilgii*"). Lithuania: Kaunas, Aliksotas, May 29, 1936, A. Minkevicius (Herb. Univ. Lithuania). Russia: Kursk, May, 1916, A. Bondarzew (F. Ross. Exs.).

P. cerasus var. *frutescens.* Germany: Berlin, Zehlendorf, May 9, 1911, R. Laubert (type of *T. pruni-acidae*); Saxony, Islebia, June, 1875, J. Kunze (Kunze, F. Sel. Exs. 168 as "*E. deformans* f. *cerasi-acidae*, forma nova").

P. fruticosa (as *T. minor*). Czechoslovakia: Kromau, May, 1913, H. Zimmerman (Fl. Boh. and Mor. Exs. II, 1, 19942). Ger-

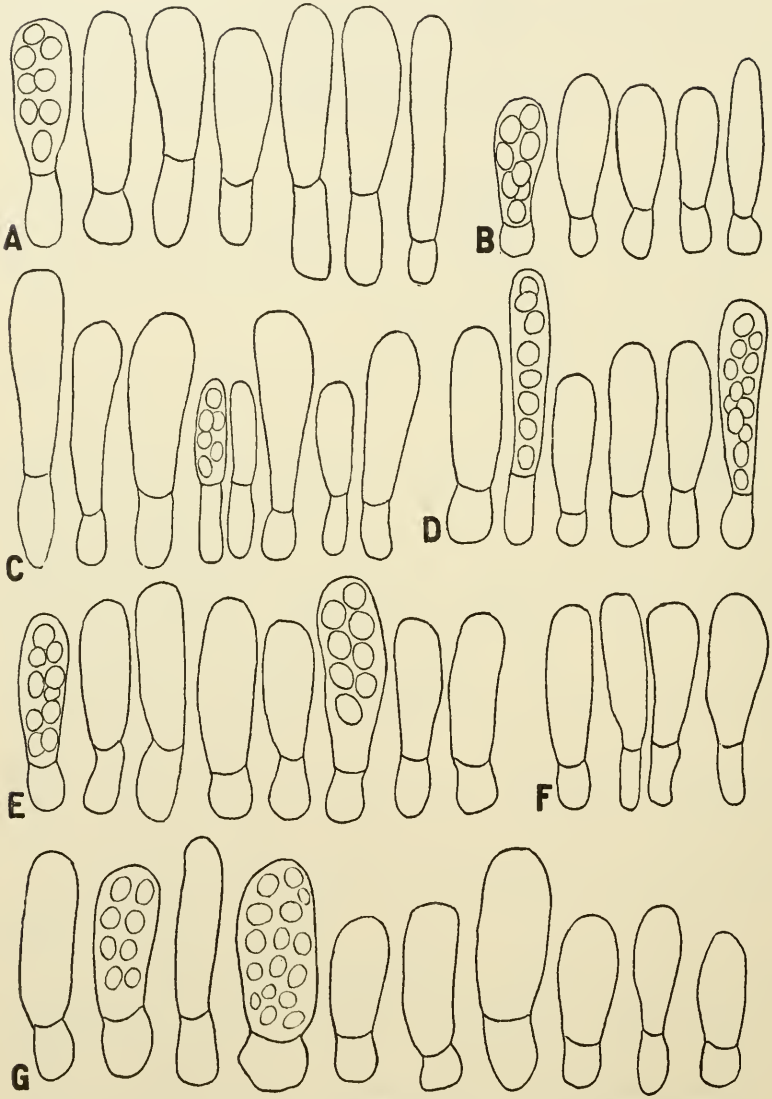

FIG. 33. Asci (× 900) A-F, of *Taphrina cerasi*. A, on *Prunus avium*; B, *P. cerasus*; C, *P. fruticosa* (*T. minor*); D, *P. pennsylvanica*; E, *P. pseudocerasus*; F, *P. yedoensis*; G, asci of *T. flectans*.

many: Hamburg, Winterhude, June 14, 1896, O. Jaap (F. Sel. Exs. 8.). Poland: Skomorochy, 1917, Wróblewski.

P. pennsylvanica. Colorado: Boulder Canyon, El Vado, July 1-2, 1941, A. J. M. Maine: Pembroke, June 9, 1934, J. R. Hansbrough (Herb. For. Path. 81694). Minnesota: Bear River, Big Bear Lake, June 29, 1947, A. J. M. New Hampshire: Cherry Mountains, near Twin Mountain, June 13, 1923, J. S. Boyce (Herb. J. S. B. 1849); Columbia, June 19, 1936, H. G. Eno (Herb. For. Path. 69964); New York: Cranberry Lake, June 12, 1926, P. Spaulding (Herb. For. Path. 16835); Ithaca, Connecticut Hill, June 7, 1940, A. J. M.; near Ringwood, May 28, 1937, W. W. Ray; Watkins Glen, June 6, 1940, A. J. M. North Carolina: Nantahala Gorge, May 29, 1941, A. J. M. Manitoba: Winnipeg, June 25, 1935, G. R. Bisby; east of Beausejour, June 23, 1947, A. J. M. Ontario: Tillsonburg, French Farm, May 19, 1938, P. G. Newell. Quebec: Duchesnay, June 13, 1939, R. Pomerleau.

P. pseudocerasus (as *T. pseudocerasi*). Japan: Ishikari, Sapporo, June, 1902, G. Yamada (Herb. Morioka Imp. Coll. Agric. and For.); Komaba, Coll. of Agric., May, 1900, S. Kusano; Tokyo, May, 1899, Shirai (Herb. Sydow in Bot. Mus. Stockholm).

P. serrulata var. *spontanea* (as *T. pseudocerasi*). Japan: Iwate, Tsunagi, May 17, 1908, G. Yamada (Herb. Morioka Imp. Coll. Agric. and For.); Morioka, Kuroishino, May 25, 1904, G. Yamada (*id.*).

P. yedoensis. Japan: Iwate, Morioka, May 6, 1931, K. Togashi (Herb. Morioka Imp. Coll. Agric. and For.); *ibid.*, May 19, 1934, *id. id.*

The forms here included are alike in size and shape of asci and in size of spores. Spores are seldom of diagnostic value in species of *Taphrina* but the ascospores of *T. cerasi* (and of the related *T. flavorubra*) are exceptionally large.

These fungi occur on closely related host-species, causing on all of them a characteristic leaf curl and on all hosts but two, perennial witches' brooms with clustered twigs showing negatively geotropic curvature.

Taphrina minor on *Prunus fruticosa* (*P. chamaecerasus*) was described by Sadebeck (1890) as causing leaf-curl but no witches' brooms. The fungus described by Laubert (1912) as "*Taphrina* sp." and named by Jaczewski (1926) *Exoascus pruni-acidae* did not cause a witches' broom. It occurred on adventitious shoots arising from roots of *Prunus cerasus*. The host was called by Laubert

P. acida K. Koch, and he stated that it was not the "Glaskirsche" *P. cerasus* var. *acida* Shrk. (*P. cerasus* L. var. *carproniana* L.). Laubert suggests that Sadebeck in describing *Taphrina minor* may have mistaken a wild form of *Prunus cerasus* for *Prunus fruticosa.*

Just who was responsible for first ascribing to *Taphrina minor* leaf curl of *Prunus avium* and *P. cerasus,* distinguishing it from witches' brooms caused by *T. cerasi* on the same hosts, has not been learned, but the practice has become rather common, especially among English authors. In the Farlow Herbarium a collection of *Taphrina cerasi* bears the following in Farlow's handwriting: "*Exoascus minor* Sad. on cultivated cherry, Deal, England, June, 1899. No Hexenbesen. Piece sent to Sadebeck." No letter from Sadebeck later than 1896 could be found among Farlow's correspondence. Sadebeck's opinion on this specimen would have been interesting since he never reported *T. minor* on *Prunus avium* or on *P. cerasus.*

Leaf curl of cultivated cherry is apparently the first stage in the establishment of a witches' broom. It may occur in trees showing no witches' brooms (collection of H. Earl Thomas at Napa, California, 1929) or in trees showing witches' brooms (collection of W. W. Ray at Ithaca, N. Y., 1938).

Why Atkinson (1894) ascribed the fungus on *Prunus pennsylvanica* to *Exoascus insititiae* is hard to understand. That fungus occurs on species of *Prunus* (*P. domestica, P. insititia*) not closely related to *P. pennsylvanica,* and causes twig malformations not at all resembling witches' brooms.

Taphrina pseudocerasi was never a well distinguished species and apparently was not recognized by Nishida (1911), who records *Taphrina cerasi* on *Prunus serrulata* Lindl. var. *spontanea* Maxim., and on *P. subhirtella* Miq. (the hosts for *T. pseudocerasi*).

The morphological similarity of the various host-forms of *Taphrina cerasi* may be seen from the following tabulation.

Taphrina cerasi on:

	Asci	*Stalk cells*
Prunus avium	20-53μ. × 7-15μ.	6-20μ. × 5-10μ.
Prunus cerasus	20-33μ. × 7- 8μ.	7-13μ. × 5- 8μ.
Prunus cerasus var. *frutescens*	20-36μ. × 7-10μ.	8-17μ. × 5- 9μ.
Prunus fruticosa	20-43μ. × 7-12μ.	7-17μ. × 5-10μ.
Prunus pennsylvanica	20-46μ. × 7-13μ.	6-20μ. × 5-10μ.
Prunus pseudocerasus	17-33μ. × 7-10μ.	7-17μ. × 7-10μ.
Prunus serrulata	17-30μ. × 7-13μ.	8-17μ. × 5-10μ.
Prunus yedoensis	20-36μ. × 5-10μ.	5-12μ. × 5-10μ.

It will be seen that the asci and stalk cells are largest on *Prunus avium*, but more specimens of the fungus on this host were examined. Also it is evident that *Taphrina minor* cannot be distinguished from *T. cerasi* by its smaller size, or if so distinguished, *T. minor* should include the form on *P. cerasus* and also the forms on Japanese cherries. (Sadebeck gave as length of asci, for *T. minor* 30-35μ, and for *T. cerasi* 30-50μ.

The occurrence of *Taphrina cerasi* on *Prunus serrulata* var. *lannesiana* is based on the report of Rathbun-Gravatt (1927) who, however, did not actually determine the fungus from this host, but only from *P. yedoensis*.

77. *Taphrina flectans* Mix

Taphrina flectans Mix, Amer. Jour. Bot. **26**:44-48. 1939.

Causing leaf-curl and witches' brooms of *Prunus emarginata* Walp.

Mycelium intercellular, perennial.

Asci hypophyllous, clavate, rounded at the apex, provided with a stalk cell. Ascospores eight, round, ovate, or elliptic, often budding in the ascus. (Fig. 33, G.)

Dimensions: Of *asci*, 20-43μ × 7-12μ; of *stalk cells*, 5-18μ × 5-12μ; of *ascospores*, 4.5-6μ × 4-5μ.

Distribution: Pacific Coast region of North America.

Material examined: California: near Donner Lake, July 13, 1938, H. N. Hansen; Mt. Sanhedrin, Sept. 4, 1939, C. G. Thompson; Mt. Shasta, July 7, 1939, W. B. Cooke (Herb. W. B. C. 13323); *ibid.*, June 16, 1939, *id.* (Herb. W. B. C. 13255); Plumas Co., Gold Lake Lodge, July 31, 1942, Lee Bonar. Idaho: Moscow, June 9, 1935, (received from J. Dearness). Oregon: Oregon Caves, Lake Mountain Trail, Aug. 12, 1929, G. D. Darker.

Much hesitation was felt at the time this fungus was described as a separate species (Mix, 1939). It is morphologically similar to *Taphrina cerasi*, and its ascus-dimensions fall within the size-range observed in that species. Predominantly the asci of *T. flectans* are somewhat shorter and broader. Consistent treatment might call for the inclusion of this form within *Taphrina cerasi* or for the removal of the fungus on *Prunus pennsylvanica* (and of perhaps other host-forms) from *Taphrina cerasi* and erection of a new species therefrom. A knowledge of biological relationships within the group of forms occurring on *Cerasus* would be helpful.

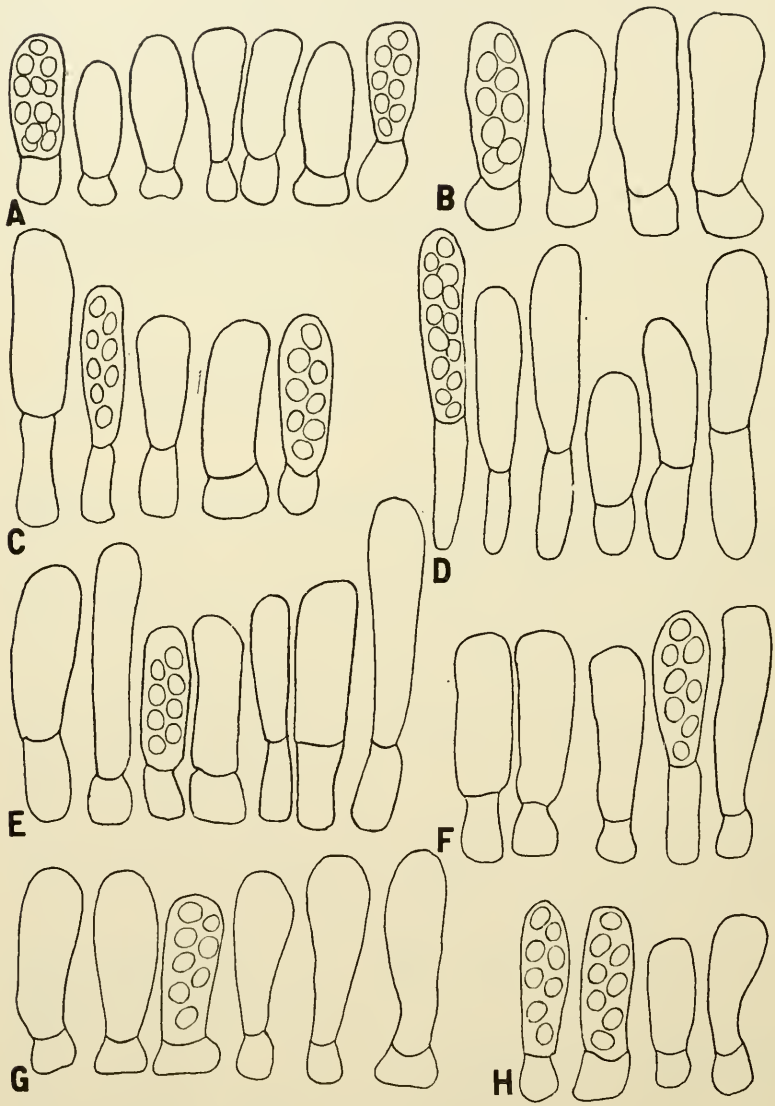

FIG. 34. Asci (× 900) of A, *Taphrina farlowii;* B, C, D, *T. andina,* C, (*T. reichei*), D, on fruits; E-H, *Taphrina confusa,* E, on *P. virginiana,* F, *P. demissa,* G, *P. melanocarpa,* H, *P. alabamensis.*

Forms on Cherries: Padus

78. *Taphrina farlowii* Sadebeck

Taphrina farlowii Sadebeck, Jahrb. Hamburg. Wissensch. Anst. **8**:61-95. 1890.
Exoascus farlowii Sadebeck, Jahrb. Hamburg. Wissensch. Anst. **10**:5-110. 1893.
Taphrina varia (Atk.) Mix, Univ. Kansas Sci. Bull. **24**:10:151-176. 1936.
E. varius Atkinson, Bull. Torr. Bot. Club **21**:372-380. 1894.

Causing leaf curl, thickened, malformed twigs (not witches' brooms), and deformed fruits (pockets) on *Prunus serotina* Ehrh.

Mycelium intercellular.

Asci epiphyllous, or covering surface of fruit, clavate, rounded at the apex, provided with a stalk cell. Ascospores eight, frequently budding in the ascus, round, ovate, or elliptic. (Fig. 34, A.)

Dimensions: Of *asci* on fruits, 13-33μ × 7-13μ, *stalk cells*, 7-13μ × 7-12μ; *asci* on leaves, 13-40μ × 7-13μ; *stalk cells*, 6-13μ × 5-10μ; of *ascospores*, 4.5-6μ × 3.5-5μ.

Distribution: eastern North America.

Material examined: Alabama: Auburn, May, 1891 (Econ. Fungi 128, leaves); *ibid.*, April 29, 1892, slide No. 93 of Atkinson collection (young stem). Arkansas: Fayetteville, April 28, 1938, J. C. Dunegan (leaves, twigs, and fruits). Florida: Gainesville, April 28, 1941, G. F. Weber (leaves). Georgia: Athens, April 22, 1936, J. H. Miller (leaves). North Carolina: Raleigh, May 11, 1936, R. F. Poole (leaves). Vermont: Peru, Stark Monument, July 27, 1927, P. Spaulding (For. Path. 16177, fruits); Smuggler's Notch, June 22, 1927 (For. Path. 16129, leaves). Germany: Charlottenburg, Schlossgarten, Aug. 6, 1891, P. Sydow (Myc. March. 3459, fruits). Locality not given, May 29, 1892, G. F. Atkinson (slide in Atkinson collection, twig).

The identity of the fungus on fruits and shoots is readily seen in the material collected in Arkansas by Dunegan. Not only is the fungus similar on all host-parts, but obviously all the asci arise from the same mycelium.

The occurrence of *Taphrina farlowii* in Germany (Sydow's specimen) must mean that the fungus was introduced with its host.

79. *Taphrina andina* Palm

Taphrina andina Palm, Svensk. Bot. Tidskr. **3**:192-195. 1909.
T. reichei Werdermann, Notizbl. Bot. Gart. and Mus. Berlin-Dahlem. **8**:221-222. 1922.
T. atkinsonii Ray, Mycologia **31**:56-75. 1939.

Causing leaf-curl, witches' brooms, and tremendously elongated (to 6 cm.) fruit-deformations (pockets) on *Prunus serotina* Ehrh. var. *salicifolia* Koehne (*P. capuli* Cav., *P. capollin* Koehne).

Mycelium intercellular.

Asci amphigenous on leaves, also covering fruits and floral parts, cylindric, rounded at the apex, provided with a stalk cell which is variable in length, somewhat narrower than the ascus, and rounded, or truncate and sometimes broadened below. Ascospores eight, round, ovate, or elliptic, often budding in the ascus. (Fig. 34, B, C, D.)

Dimensions: Of *asci,* 23-40μ × 7-13μ; of *stalk cells,* 7-26μ × 5-12μ; of *ascospores,* 4-5.5μ × 3.5-4.5μ.

Distribution: Ecuador, Mexico.

Material examined: ECUADOR: Valle de Chillo, Nov. 13, 1924, F. L. Stevens (Fungi of Ecuador 288, leaves). MEXICO: near City of Mexico, 1920-1921, C. Reiche (Bot. Mus. Berlin, type of *T. reichei,* leaves); Valley of Mexico, June 5, 1896, C. C. Pringle (Farl. Herb., witches' broom); Durango, San Ramon, April 21-May 8, 1906, E. Palmer (Plants of Mexico 173, fruits and floral parts). No locality or date (slide in Atkinson collection).

The type specimen of *Taphrina andina* has apparently been lost. According to Patouillard and Lagerheim (1895) the fungus was collected by Lagerheim who, in giving it to Palm, stated that he had not seen a witches' broom on the host. Palm (1909) makes the lack of a witches' broom his chief reason for distinguishing the fungus from *Taphrina cerasi.* In 1939 no specimen of *T. andina* could be found among Lagerheim's collections at Stockholm's Högskola. The collection by Stevens corresponds well with Palm's description of *T. andina.*

There is no reason for considering the fungus causing leaf curl and witches' brooms as different from that deforming fruits and floral parts. The asci on fruits are longer and narrower (26-40μ × 7-10μ) than on leaves (23-36μ × 8-14μ). Stalk cells from fruits are also longer and narrower (10-26μ × 5-9μ) than those from leaves (7-23μ × 7-12μ). Asci (and stalk cells) on stamens and calyx lobes are intermediate in size. Similar size-differences in asci from leaves and from fruits exist in *Taphrina confusa, T. farlowii, T. communis* and other species.

It is noteworthy that where collection dates are given the fungus on leaves was collected later in the season than on fruits. This is in accord with the writer's experience with *Taphrina confusa* on *P. virginiana* var. *demissa* in Colorado. Leaf curl of this host can be collected long after the diseased fruits and inflorescences have been shed.

Fig. 35. Asci (× 900) of A, *Taphrina padi;* B, *T. thomasii;* C, *T. purpurascens.*

No asci nor stalk cells as long as those reported by Ray (1939) were seen in this study. A striking feature was the variability in length of the stalk cell in different microscopic mounts, whether from leaves, fruits, or floral parts.

80. *Taphrina padi* (Jacz.) Mix

Taphrina padi (Jacz.) Mix Trans. Kansas Acad. Sci. **50**:77-83. 1947.
T. pruni Tulasne, Ann. Sci. Nat. 5 ser. Bot. **5**:122-136. 1866, in part.
T. pruni Tul. var. *padi* Jaczewski, Pocket Key for the determination of fungi. Part I. Exoascales. Leningrad. 1926.

Causing deformed fruits (pockets) on *Prunus padus* L.

Mycelium intercellular.

Asci clavate, rounded at the apex, stalk cells variable, sometimes widened at the base. Ascospores eight, round, ovate, or elliptic, frequently budding in the ascus. (Fig. 35, A.)

Dimensions: Of *asci,* 26-46μ × 8-13μ; of *stalk cells,* 8-26μ × 7-10μ; of *ascospores,* 5-6μ × 4-5μ.

Distribution: Europe.

Material examined: SWEDEN: Jämtland, Storlien, Aug. 24, 1939, A. J. M.; Lappland, Sulitölma near Lairo, July 29, 1938, T. Arwidsson; Stockholm, Experimentalfältet, July 5, 1939, C. Hammarlund (type).

This fungus has long been considered to be identical with *Taphrina pruni,* though Sadebeck (1893) suggests that the fungi on *Prunus domestica* and *P. padus* may not be the same. Jaczewski (1926) separated the form on *P. padus* as a variety. *Prunus padus* is so distantly related to *P. domestica* and *P. insititia,* that it seems very unlikely that the two fungi are identical. *Taphrina padi* has a distinctive morphology. It is clearly more closely related to *Taphrina farlowii* and to *T. confusa* than to *T. pruni.*

81. *Taphrina confusa* (Atk.) Giesenhagen

Taphrina confusa (Atk.) Giesenhagen, Flora **81**:267-361. 1895.
Exoascus confusus Atkinson, Bull. Torr. Bot. Club **21**:372-380. 1894.
T. unilateralis (Pk.) Mix, Univ. Kansas Sci. Bull. **24**:10:151-176. 1936.
E. unilateralis Peck, New York State Mus. Nat. Hist. Ann. Rept. **51**:267-312. 1898.
T. cecidomophila (Atk.) Giesenhagen, l.c.
E. cecidomophilus Atkinson, l.c.

Deforming fruits and all floral parts of *Prunus alabamensis* Mohr, *P. virginiana* L., *P. virginiana* L. var. *demissa* Torr., and *P. virginiana* L. var. *melanocarpa* Sarg.

Mycelium intercellular.

Asci amphigenous on leaves, also covering surfaces of fruits and floral parts, clavate, rounded at the apex; stalk cells variable in

size and shape, often irregular in outline. Ascospores eight, round, ovate, or elliptic, frequently budding in the ascus. (Fig. 34, E-H).

Dimensions: Of *asci,* 23-53μ × 7-13μ; of *stalk cells,* 6-27μ × 5-13μ; of *ascospores,* 4-7μ × 3.5-6μ.

Distribution: North America.

Material examined: P. alabamensis. Georgia: Pine Mountain, May 12, 1936, J. H. Miller.

P. virginiana. Florida: Gainesville, April 17, 1936, G. F. Weber (leaves). Massachusetts: Cape Cod, Sandwich, June 6, 1937, D. H. Linder (leaves). Michigan: Glen Haven, Day State Park, June 1, 1941, E. A. Bessey (leaves, fruits, and other floral parts). Minnesota: Bear River, Big Bear Lake, June 25, 1947, A. J. M. Nebraska: Dixon Co., Allen, May, 1940, R. W. Goss (leaves); Lincoln, June 3, 1940, L. B. Walker (fruits). New York: Brookton, June, 1904, Fletcher (Cornell Univ. Dept. Plant Path. 20,000, fruits); Etna, June, 1894, G. F. Atkinson (Atkinson Coll. 1192, fruits deformed by insect larvae; apparently type material of *Exoascus cecidomophilus*); *ibid., id.* (two slides in Atkinson Collection, numbered 1192); Evans Mills, June, C. H. Peck ("type No. 1" of *E. unilateralis,* leaves); North Elba, June, 1897, *id.* ("type No. 2" of *E. unilateralis,* leaves); Sempronius, June 5, 1937, W. W. Ray (leaves and fruits); *ibid.,* June 7, 1936, *id.* (fruits and other floral parts). Nova Scotia: Pictou Co., Aug., 1910, I. H. Crowell (fruits). Ontario: London, June, 1893, J. Dearness (N. A. F. 2285, fruits). Finland: near Mustiala, June, 1886, P. A. Karsten (F. Eur. 3473, fruits).

P. virginiana var. *demissa.* California: Berkeley, May 15, 1937, H. Earl Thomas (leaves); Mt. Shasta, Wagon Creek, June 7, 1941, W. B. Cooke (Herb. W. B. C. 15506, leaves, young ovaries, and other floral parts). Colorado: Boulder Canyon, El Vado, July 5, 15, 1943, A. J. M. (leaves); Cross Ruxton, July 5, 1906, F. E. and E. S. Clements (Crypt. Form. Col. 311, leaves); Manitou, Manitou Trail, July 13, 1895, L. H. Pammel (Herb. L. H. P. 114, leaves); Ute Pass, slide No. 97 of Atkinson Collection (fruits). Idaho: Farragut, May, 1944, R. H. Thompson (leaves and inflorescences). Oregon: Eugene, May 30, 1930, J. R. Hansbrough (Herb. J. R. H. 612, leaves). Washington: Klickitat Co., Gulers, May 30, 1920, J. S. Boyce (Herb. J. S. B. 494, leaves); Pullman, June 20, 1893, C. V. Piper (F. Wash. 138, floral parts).

P. virginiana var. *melanocarpa.* Colorado: Fort Collins, June, 1935 (Bot. Dept. Colorado State Coll., leaves). Montana: Madi-

son Co., Madison River Canyon, June 3, 1914, H. M. Jennison (Flor. Mont. 107, leaves).

The case for synonymy of *Taphrina confusa* and *T. unilateralis* has been well presented by Ray (1939). Numerous collections in which leaves, fruits (or ovaries) and other floral parts are affected, and in which the fungus is morphologically similar on all affected parts, leave no doubt as to this synonymy. Peck (1898) gave measurements for *"Exoascus unilateralis"* as: asci, 40-52μ × 13-16μ; stalk cells, 13-16μ broad and "about as long." Examination of Peck's type specimens showed the asci to be 23-30μ × 8-13μ; stalk cells, 8-18μ × 7-10μ. Obviously Peck's measurements are in error.

The fungus on *Prunus alabamensis* with asci measuring 23-34μ × 10-12μ, stalk cells 8-10μ × 9-11μ is intermediate in size between *Taphrina farlowii* and *T. confusa*. It might well have been assigned to *T. farlowii* or called a new species. Its host is apparently more closely related to *P. serotina* than to *P. virginiana*. It is tentatively placed with *Taphrina confusa* because it deforms all floral parts, as does that fungus.

The collection by Piper at Pullman, Washington, is interesting. All floral parts, petals, sepals, stamens, and calyx-cup are enlarged and bear asci, while the ovaries are prolonged into long conical "pockets" 2-3 cm. long, with a curving beak, suggestive of *Taphrina andina* (*T. atkinsonii*).

Forms on Cherries: Laurocerasus

82. *Taphrina thomasii* Mix

Taphrina thomasii Mix, Trans. Kansas Acad. Sci. **50**:77-83. 1947.

Causing witches' brooms on *Prunus ilicifolia* Walp.

Mycelium intercellular.

Asci hypophyllous, cylindric-clavate, rounded at the apex; stalk cell somewhat variable, occasionally forked below, sometimes lacking. Ascospores eight, round, ovate, or elliptic, frequently budding in the ascus. (Fig. 35, B.)

Dimensions: Of *asci,* 20-35μ × 6-10μ (or if stalk cell lacking 32-38μ × 6-10μ); of *stalk cells,* 8-16μ × 6-8μ; of *ascospores,* 4-7μ × 4-5μ.

Distribution: California.

Material examined: CALIFORNIA: Santa Clara Co., Los Altos, 1943, H. Earl Thomas (type); *ibid.,* May 8, 1947, *id.* (co-type).

In this species the stalk cell is cut off late and is sometimes lacking in the mature ascus. The ascus emerges from the chlamydo-

spore, the thicker wall of the latter persisting around the stalk cell or ascus-base.

HOST INDEX TO SPECIES OF *TAPHRINA* ON PRUNUS

Prunus alabamensis Mohr
Taphrina confusa (Atk.) Gies.
Prunus americana Marsh.
Taphrina communis (Sadeb.) Gies.
Prunus angustifolia Marsh.
Taphrina communis (Sadeb.) Gies.
Prunus armeniaca L.
Taphrina armeniacae Georg. and Bad.
Prunus armeniaca L. var. *ansu* Maxim.
Taphrina mume Nish.
Prunus avium L.
Taphrina cerasi (Fkl.) Sadeb.
Prunus besseyi Bailey
Taphrina flavorubra Ray
Prunus cerasifera Ehrh. var. *divaricata* Bailey
Taphrina pruni Tul.
Prunus cerasus L.
Taphrina cerasi (Fkl.) Sadeb.
Prunus cerasus L. var. *frutescens* (Neilr.) Schneid.
Taphrina cerasi (Fkl.) Sadeb.
Prunus communis Arcang. var. *amara* Schneid.
Taphrina deformans (Berk.) Tul.
Prunus communis Arcang, var. *dulcis* Schneid.
Taphrina deformans (Berk.) Tul.
Prunus domestica L.
Taphrina pruni Tul.
Prunus emarginata Walp.
Taphrina flectans Mix
Prunus fruticosa Pall.
Taphrina cerasi (Fkl.) Sadeb.
Prunus hortulana Bailey
Taphrina communis (Sadeb.) Gies.
Prunus hortulana Bailey var. *mineri* Bailey
Taphrina communis (Sadeb.) Gies.
Prunus humilis Bunge
Taphrina cerasi-microcarpae (Kuschke) Laubert
Prunus ilicifolia Walp.
Taphrina thomasii Mix
Prunus incisa Thunb.
Taphrina truncicola Kus.
Prunus insititia L.
Taphrina pruni Tul.
Prunus lanata Mack. and Bush.
Taphrina communis (Sadeb.) Gies.
Prunus mandshurica Koehne
Taphrina mume Nish.
Prunus maritima Marsh.
Taphrina communis (Sadeb.) Gies.
Prunus maximowiczii Rupr.
Taphrina truncicola Kus.
Prunus microcarpa C. A. Mey.
Taphrina cerasi-microcarpae (Kuschke) Laubert
Prunus microphylla (HBK) Gray
Taphrina mexicana H. and P. Syd.
Prunus mume Sieb. and Zucc.
Taphrina mume Nish.

Prunus munsoniana Bailey
Taphrina communis (Sadeb.) Gies.
Prunus nigra Ait.
Taphrina communis (Sadeb.) Gies.
Prunus padus L.
Taphrina padi (Jacz.) Mix
Prunus pennsylvanica L.
Taphrina cerasi (Fkl.) Sadeb.
Prunus persica L.
Taphrina deformans (Berk.) Tul.
Prunus pseudocerasus Lindl.
Taphrina cerasi (Fkl.) Sadeb.
Prunus pumila L.
Taphrina flavorubra Ray
Prunus pumila L. var. *susquehanae* Jaeg.
Taphrina flavorubra Ray
Prunus salicina Lindl.
Taphrina communis (Sadeb.) Gies.
Prunus serotina Ehrh.
Taphrina farlowii Sadeb.
Prunus serotina Ehrh. var. *salicifolia* Koehne
Taphrina andina Palm
Prunus serrulata Lindl. var. *lannesiana* Rehd.
Taphrina cerasi (Fkl.) Sadeb.
Prunus serrulata Lindl. var. *spontanea* Wils.
Taphrina cerasi (Fkl.) Sadeb.
Prunus spinosa L.
Taphrina pruni Tul.
Prunus subcordata Benth.
Taphrina pruni-subcordatae (Zeller) Mix
Prunus subhirtella Miq.
Taphrina cerasi (Fkl.) Sadeb.
Prunus tomentosa Thunb.
Taphrina cerasi-microcarpae (Kuschke) Laubert
Prunus umbellata Ell.
Taphrina communis (Sadeb.) Gies.
Prunus ussuriensis Koval. and Kost.
Taphrina pruni Tul.
Prunus virginiana L.
Taphrina confusa (Atk.) Gies.
Prunus virginiana L. var. *demissa* Torr.
Taphrina confusa (Atk.) Gies.
Prunus virginiana L. var. *melanocarpa* Sarg.
Taphrina confusa (Atk.) Gies.
Prunus yedoensis Matsum.
Taphrina cerasi (Fkl.) Sadeb.

VII. SPECIES ON ANACARDIACEAE

Rhus

83. *Taphrina purpurascens* Robinson

Taphrina purpurascens Robinson, Ann. Bot. 1:163-176. 1887.
Ascomyces deformans Berk. var. *purpurascens* Ellis and Everhart, North American Fungi No. 1886.

Causing leaf-curl, with great enlargement and reddish-purple coloration of leaves of *Rhus copallina* L., *R. coriaria* L., *R. glabra* L., and *R. typhina* L.

Mycelium intercellular.

Asci hypophyllous or amphigenous, dumbbell-shaped, constricted in the middle, rounded at the apex, rounded or truncate at the base, which is sometimes wider than the apex. No stalk cell. Ascospores eight, frequently budding in the ascus, round, ovate, or elliptic. (Fig. 35, C.)

Dimensions: Of *asci*, 17-40μ × 9-17μ (width of constricted part 6-12μ); of *ascospores*, 3-6μ × 3-5μ.

Distribution: North America, France, Sicily.

Material examined: Rhus coriaria. France: Mountpellier, May 13, 1905, G. Arnaud; *ibid.*, May 21, 1914, *id.*

Rhus copallina. Arkansas: Fayetteville, June 10, 1937; *ibid.*, May 24, 1941, J. C. Dunegan and A. J. M.; Johnson Co., May 13, 1935, W. C. Amstein. Kansas: Neosho Co., 1 mi. E. of Morehead, June 30, 1947, R. L. McGregor; Wilson Co., 3 mi. E. of Neodesha, July 1, 1947, R. L. McGregor; Woodson Co., 3 mi. N. W. of Yates Center, July 1, 1947, R. L. McGregor. Massachusetts: Manchester, July, 1880, W. C. Sturgis (Econ. F. 120a); Pigeon Cove and Magnolia, July 28, 1890, A. B. Seymour (Econ. F. 120b). New Jersey: Newfield, June, 1886, Ellis and Everhart (N. A. F. 1886). Virginia: 1935, S. A. Wingard.

R. glabra. Connecticut: New Haven, R. Thaxter (Farl. Herb. 3661).

R. typhina. Connecticut: New Haven, May, 1889, R. Thaxter; *ibid.*, West Rock, *id.* (Farl. Herb. 1498).

Material was distributed in Fungi Columbiana 4024, as *Exoascus purpurascens* (E. and E.) Sacc. on *Rhus aromatica* Ait., Lake Huron, Ontario, Canada, Aug. 10, 1912, J. Dearness. Several specimens of this collection have been seen and in none of them was a fungus found. The reddish distortions of the leaves appear to be the work of insects.

Montemartini (1940) reports this fungus as occurring on *Rhus coriaria* L. in Sicily.

VIII. SPECIES ON ACERACEAE

Acer.

84. *Taphrina acerina* Eliasson

Taphrina acerina Eliasson, Bih. K. Svensk. Vetensk. Akad. Handl. **20**:3:4: 3-6. 1895.
Exoascus acerinus (Eliass.) Saccardo, Sylloge Fungorum. **14**:823.

Causing leaf-blight and (according to Eliasson) witches' brooms of *Acer platanoides* L. Affected areas on leaves are yellow-brown, watersoaked in appearance (papery when dry), extending from margin in between veins, affecting part or all of the leaf.

Mycelium subcuticular.

Asci amphigenous, broad-cylindric, rounded or truncate at the apex, stalk cell broader than the ascus. Ascospores eight, round, ovate, or elliptic, often budding in the ascus. Ascus emerging from the chlamydospore by rupture of the chlamydospore wall. (Fig. 36, A.)

Dimensions: Of *asci,* 12-23μ × 8-12μ; of *stalk cells,* 7-13μ × 10-20μ; of *ascospores,* 4-5μ × 3.5-5μ.

Distribution: Norway, Sweden, Russia.

Material examined: NORWAY: Anst-Agder, Møglestne in Vestre Moland, June 16, 1932, I. Jørstad. SWEDEN: Uppland, Uppsala, Stafsund, June 28, 1893, A. G. Eliasson; Västergotland, Mariestad, June, 1911, N. Sylven.

85. *Taphrina acericola* Massalongo

Taphrina acericola Massalongo, Malpighia **8**:97-130. 1894.
Exoascus acericolus (Massal.) Saccardo, Sylloge Fungorum **11**:436.
T. jaczewski Palm, Arkiv. Bot. **15**:1-14. 1917.
E. confusus Jaczewski, Bull. Jard. Imp. Bot. St. Petersburg. **1**:7-13. 1901.

Causing small (2-3 mm. diam.), well defined, definitely margined spots, with a tendency toward extension and coalescence, on leaves of *Acer campestre* L.

Mycelium subcuticular.

Asci hypophyllous or amphigenous, short-cylindric to ellipsoid, rounded at the apex; stalk cell short and broader than the ascus; ascospores eight, round, ovate, or elliptic, often budding in the ascus. Ascus emerging from the chlamydospore by rupture of the chlamydospore wall. (Fig. 36, B, C.)

Dimensions: Of *asci,* 16-26μ × 6-13μ; of *stalk cells,* 4-13μ × 8-17μ; of *spores,* 4-5.5μ × 3.5-4.5μ.

Distribution: Italy, Caucasus.

Material examined: As *T. acericola.* ITALY: Spiassi, May 28,

Fig. 36. A, asci, ascus emerging from chlamydospore of *Taphrina acerina;* B. asci of *T. acericola;* C, asci, chlamydospores, and emerging ascus of *T. acericola* (*T. jaczewski*); D. asci of *T. sacchari;* E, *T. pseudoplatani;* F, *T. bartholomaei.* All × 900.

1895 (Ex. Herb. C. Massal.). As *T. jaczewski.* RUSSIA: Trancaucasia, Kedanah, July, 1890 (part of type); Central Russia, June 13, 1913, N. Troussova (Herb. Inst. Mycol. et Phytopath. Jaczewski).

Jaczewski (1901) distinguished *Exoascus confusus* from *Taphrina acericola* by the fact that its mycelium is perennial in the branches and induces witches' brooms. The type material shows only small spots on leaves (quite like those caused by *T. acericola*), but assuming that Jaczewski is correct, the formation of witches' brooms would be insufficient ground for separation of this fungus from *T. acericola,* when the two are morphologically indistinguishable.

This fungus is very similar to *Taphrina acerina,* the asci of the two forms being nearly alike in size and shape. In both fungi the ascus emerges from the chlamydospore by rupture of the chlamydospore wall. Both are reported as causing witches' brooms. It is possible that they are the same species.

86. *Taphrina sacchari* Jenkins

Taphrina sacchari Jenkins, Jour. Wash. Acad. Sci. 28:8:353-358. 1938.

Causing small, round to irregular, brownish marginal spots, which may coalesce to form blighted areas extending inward between main veins, on leaves of *Acer saccharum* Marsh., and *A. migrum* Michx.

Mycelium subcuticular.

Asci hypophyllous, often scattered, in places close packed, short-cylindric, rounded at the apex; stalk cells short and broad, sometimes broader than the ascus. Ascospores eight, round, ovate, or elliptic, often budding in the ascus. (Fig. 36, D.)

Dimensions: Of *asci,* 13-30μ × 6-13μ; of *stalk cells,* 5-13μ × 8-20μ; of *ascospores,* 3.5-6μ × 3-5μ.

Distribution: eastern and central North America.

Material examined: Acer saccharum. ARKANSAS: Fayetteville, May 2 and May 5, 1935, V. H. Young; *ibid.,* June, 1935, J. C. Dunegan; *ibid.,* May 21, 1937, V. H. Young; *ibid.,* May 8, 1940, *id.; ibid.,* May 24, 1941, J. C. Dunegan and A. J. M.; Mountainburg, May 25, 1941, A. J. M. KANSAS: Independence, May 11, 1944, G. W. Stafford. MAINE: Rockport, June 26, 1922, J. Achorn (U. S. D. A. Path. and Myc. Coll. 68554). PENNSYLVANIA: Williamsport, June 17, 1935, R. S. Kirby (from L. O. Overholts).

Jenkins (1938) in describing *Taphrina sacchari* mentioned its close similarity to *T. acericola* but considered that she had evidence of a biological difference between the two. The morphological similarity is indeed very close and it may be that the two species are identical. They are here treated as separate species because of differences in host relationships and geographic distribution.

887. *Taphrina bartholomaei* nomen novum

Taphrina bartholomaei nomen novum.
T. aceris (Dearn. and Barth.) Mix, Univ. Kansas Sci. Bull. 24:10:151-176. 1936.
Exoascus aceris Dearn. and Barth. (Dearness, Mycologia 9:345-364. 1917.)

Causing small (ca. 5-10 mm. diam.), brown, unthickened, necrotic spots on leaves of *Acer grandidentatum* Nutt.

Mycelium subcuticular.

Asci hypophyllous, epiphyllous, or amphigenous, short-cylindric, rounded at the apex; stalk cell short, often broader than the ascus. Ascospores eight, round, ovate, or elliptic, often budding in the ascus. (Fig. 36, F.)

Dimensions: Of *asci,* 20-40μ × 8-13μ; of *stalk cells,* 7-17μ × 7-17μ; of *ascospores,* 4-5.5μ × 3.5-4.5μ.

Distribution: Utah.

Material examined: Utah: Salt Lake Co., Parley's Canyon, June 29, 1915, Bartholomew and Garrett (F. Columb. 5018).

The name *Exoascus aceris* applied to this fungus by Dearness, and the new combination made by Mix (1936a) are invalid, since Fisch (1885) had described a fungus on *Acer platanoides* as *Exoascus aceris* Linhart. This fungus was declared identical with *Taphrina polyspora* Sorok. by Johanson (1886).

In renaming this fungus it would have been desirable to honor Dearness but that had been done by Jenkins (1939) in naming a fungus on *Acer rubrum.* The species is therefore named after Bartholomew, who took part in its collection.

88. *Taphrina pseudoplatani* (Massal.) Jaap

Taphrina pseudoplatani (Massal.) Jaap, Ann. Mycol. 15:97-124. 1917.
Taphrina polyspora (Sorok.) Johans. var. *pseudoplatani* Massalongo, Bull. Soc. Bot. Ital. 1892:197-199.
T. acericola (Massal.) var. *pseudoplatani* Massalongo, Malpighia 8:97-130. 1894.

Causing irregular, unthickened, gray to blackish spots (0.5 to 1 cm. diam.) with indefinite margin, on leaves of *Acer pseudoplatanus* L.

Mycelium subcuticular.

Asci hypophyllous, short-cylindric, rounded at apex, stalk cell short, usually not wider than the ascus. Ascospores eight, round, ovate, or elliptic, often budding in the ascus. (Fig. 36, E.)

Dimensions: Of *asci,* 13-26μ × 8-13μ; of *stalk cells,* 6-13μ × 8-13μ; of *ascospores,* 4-5.5μ × 3.5-4.5μ.

Distribution: Italy, Switzerland.

Material examined: Switzerland: near Grindelwald, Aug. 3,

1910, O. Jaap. No locality, date or collector (Herb. C. Massalongo and Ex Herb. Bresadola in Bot. Mus. Stockholm).

This fungus seems very close to *Taphrina acericola,* from which it is distinguished by its narrower stalk cell. It is significant that both fungi occur in Italy. Perhaps further study will show them to be identical.

89. *Taphrina polyspora* (Sorok.) Johanson

Taphrina polyspora (Sorok.) Johanson, Ofvers. of K. Svensk. Vetensk. Akad. Forhandl. **1885**:29-47. 1886.
Ascomyces polysporus Sorokin, Ann. Sci. Nat. 6 ser. Bot. **4**:72. 1876.
Exoascus aceris Linhart, Fungi Hungarici (Fisch, Bot. Centbl. **22**:126-127. 1885).

Causing small (ca. 1 cm. diam.) roundish spots or larger irregular areas, blackish, unthickened, on leaves of *Acer. orientale* L. and *A. tataricum* L.

Mycelium subcuticular.

Asci hypophyllous, short-cylindric, rounded at the apex, often widened at the base forming a fairly definite foot, lacking a stalk cell. Ascospores eight, round, ovate, or elliptic, budding at once and filling the asci with small round to elliptic blastospores. (Fig. 37, A.)

Dimensions: Of *asci,* 26-60μ × 8-23μ; of *ascospores,* 4.5-5μ × 4-4.5μ; of *blastospores,* 2-4μ × 2-4μ, or smaller.

Distribution: Europe.

Material examined: A. orientale. GREECE: Messenie, Selitsa, Mt. Taygetos, April 24, 1908, R. Maire (Mission Bot. Orient, 1908, 3,200.). *A. tataricum.* GERMANY: Bavaria, Freising, Garden of Lyceum, June, 1902, J. E. Weiss (Myc. Germ. 173). RUSSIA: Petropolitana, Peterhof, A. Jaczewski (Cornell Univ. Dept. Plant Path. 17092). SWEDEN: Uppland, Uppsala, June, 1884, C. J. Johanson.

90. *Taphrina letifera* (Pk.) Saccardo

Taphrina letifera (Pk.) Saccardo, Sylloge Fungorum **10**:67.
Ascomyces letifer Peck, New York State Mus. Nat. Hist. Ann. Rept. **40**: 39-77. 1887.

Causing large, indefinitely margined spots on leaves or blighting whole leaves of *Acer spicatum* Lam. Spots when fresh may be green or reddened, but in dried specimens are black.

Mycelium intercellular.

Asci hypophyllous or amphigenous, broad-cylindric, rounded or truncate at the apex; stalk cell short, frequently wider than the ascus. Ascospores eight, round, ovate, or elliptic, often budding in the ascus. (Fig. 37, B, C.)

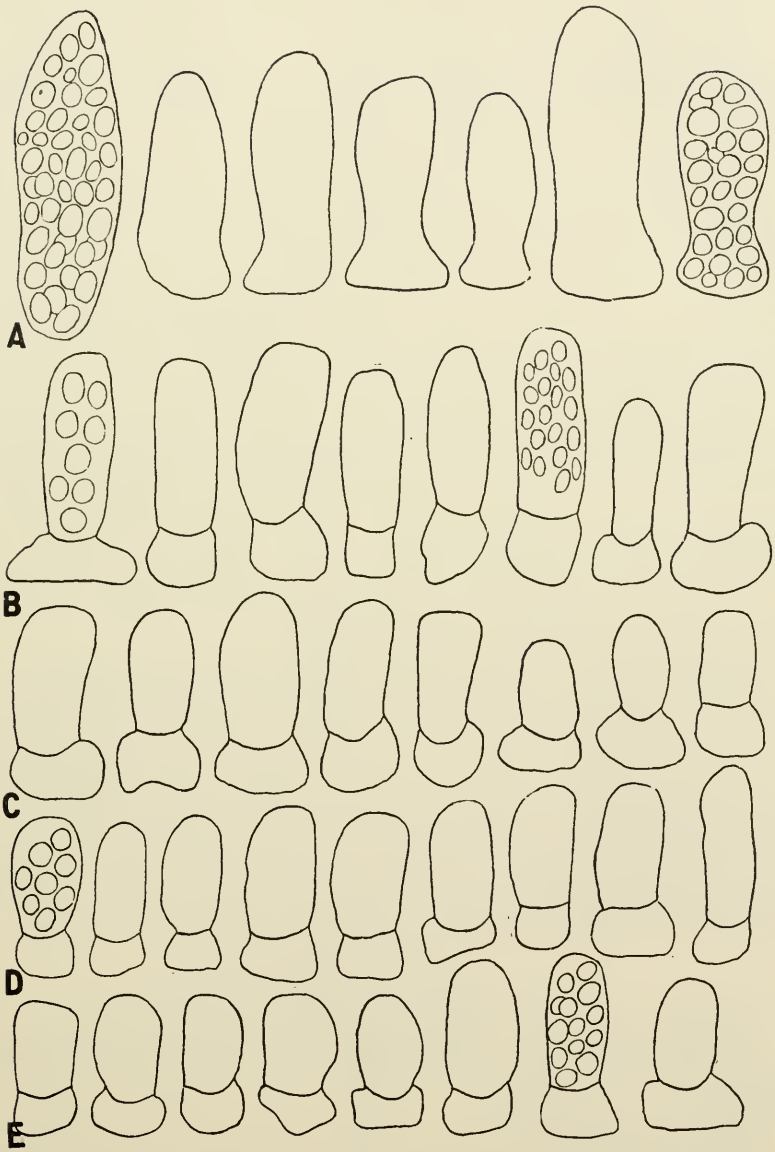

Fig. 37. Asci (× 900) of A, *Taphrina polyspora;* B, C, *T. letifera;* D, E, *T. darkeri.*

Dimensions: Of *asci,* 14-35μ × 8-18μ; of *stalk cells,* 6-13μ × 8-25μ; of *spores,* 4-5μ × 4-5μ.

Distribution: eastern North America.

Material examined: MASSACHUSETTS: Mt. Wachusett, June 12, 1936, G. D. Darker. MINNESOTA: Bear River, Big Bear Lake, June 28, 1947, A. J. M. NEW YORK: Elizabethtown, June, 1886, C. H. Peck (part of type); Labrador Lake, near Apulia, June 25, 1940, A. J. M. NORTH CAROLINA: Nantahala Gorge, May 29, 1941, *id.*

Peck's measurements of this fungus are in decimal fractions of inches. When converted into millimeters they become: Asci, 40-50μ × 15-20μ. Examination of Peck's type material shows these measurements to be wrong. They would not be so far wrong if Peck had been considering the whole ascus, including the stalk cell. He makes no mention of the stalk cell.

Jenkins (1938) gives dimensions of asci as 36-50μ × 14-20μ, of stalk cells as 14-20μ × 17-25μ. Careful study of the type material as well as of other specimens mentioned above has revealed no asci so large as these. Asci on the lower surface of the leaf are regularly smaller than those on the upper.

Peck spelled his species name "letifer." Saccardo inserted an "h" in renaming the fungus *Taphrina lethifera.* As "letifer" is good Latin, Saccardo's change was unnecessary.

Jenkins and Ray (1940) have assigned the fungus collected by them on *Acer spicatum* at Labrador Lake to *Taphrina dearnessii* on the basis of similarity of host lesions and size of asci. Material collected at Labrador Lake by the writer agrees in all respects with *Taphrina letifera.* It may be that *Taphrina dearnessii* and *T. letifera* will prove to be one and the same species; the two fungi were found abundantly in the same locality (Bear River, Minn.) in 1947. In any event convincing evidence that two distinct species of *Taphrina* occur on *Acer spicatum* is lacking.

91. *Taphrina darkeri* Mix

Taphrina darkeri Mix, Trans. Kansas Acad. Sci. **50**:77-83. 1947.

Causing small brown necrotic spots on leaves of *Acer circinatum* Pursh.

Mycelium intercellular.

Asci amphigenous, broad-cylindric, rounded or truncate at the apex; stalk cell short, often wider than the ascus; ascospores eight, round, ovate, or elliptic, frequently budding in the ascus. (Fig. 37, D, E.)

Dimensions: Of *asci,* 16-33μ × 8-13μ; of *stalk cells,* 5-12μ × 10-17μ; of *spores,* 4-4.5μ × 3.5-4μ.

Distribution: Oregon.

Material examined: OREGON: Oregon Caves, head of Limestone Creek, Aug. 15, 1929, G. D. Darker (Herb. Arnold Arboretum 5077).

92. *Taphrina nikkoensis* Kusano

Taphrina nikkoensis Kusano, Bot. Mag. Tokyo. **21**:65-67. 1907.
Exoascus nikkoensis (Kus.) Saccardo, Sylloge Fungorum **22**:763.

Causing small (ca. 5 mm. diam.) round to irregular, yellowish, unthickened spots, or larger blighted areas on leaves of *Acer diabolicum* K. Koch. var. *purpurascens* Rehd.

Mycelium subcuticular.

Asci hypophyllous, cylindric, with rounded apex, rather variable in size and shape; stalk cell no wider than the ascus. Ascospores eight, round, ovate, or elliptic, often budding in the ascus. (Fig. 38, A.)

Dimensions: Of *asci,* 20-50μ × 8-13μ; of *stalk cells,* 8-15μ × 7-13μ; of *spores,* 4-6μ × 3.5-5μ.

Distribution: Japan.

Material examined: JAPAN: Nikko, May 27, 1906, S. Kusano (Received from Kusano, presumably part of type).

93. *Taphrina dearnessii* Jenkins

Taphrina dearnessii Jenkins, Jour. Washington Acad. Sci. **29**:222-230. 1939.

Causing small, well defined dark brown to black, unthickened spots, sometimes coalescing to involve large areas of the leaf-blade, on leaves of *Acer rubrum* L.

Mycelium subcuticular.

Asci amphigenous, short-cylindric, rounded or truncate at the apex, stalk cell short, often broader than the ascus. Ascospores eight, round to elliptic, often budding in the ascus. (Fig. 38, B.)

Dimensions: Of *asci,* 17-35μ × 8-17μ; of *stalk cells,* 6-13μ × 10-23μ; of *ascospores,* 4.5-6μ × 3-5μ.

Distribution: eastern North America.

Material examined: MICHIGAN: Indian River, July 1, 1947, A. J. M.; between Isabella and Cooke, July 1, 1947, *id.* MINNESOTA: Bear River, Big Bear Lake, June 29, 1947, A. J. M.; Janet Lake, 28 mi. N. of Floodwood, July 1, 1947, *id.* NEW YORK: Ithaca, Ringwood Preserve, June 11, 1940, A. J. M. NORTH CAROLINA: Nantahala Gorge, May 29, 1941, *id.* VIRGINIA: Halifax Co., Nathalie, May 13, 1935, E. R. Mickle. QUEBEC: Davidson, June, 1938, I. L. Connors.

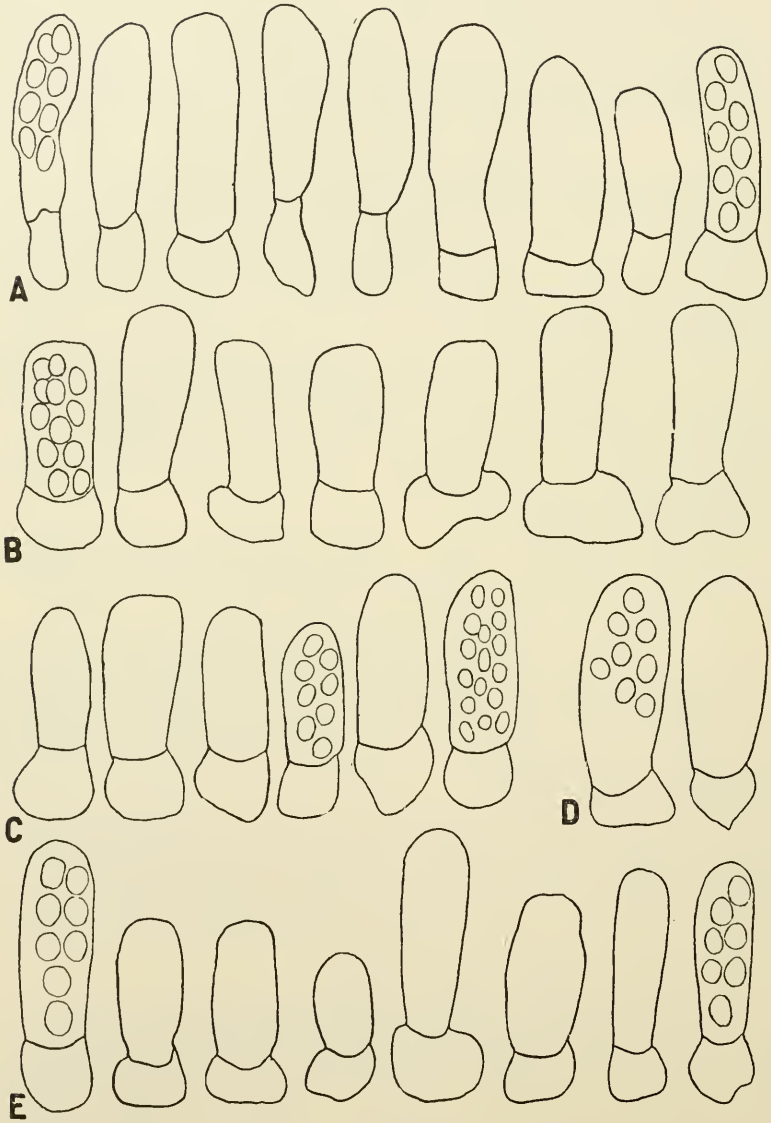

FIG. 38. Asci (× 900) of A, *Taphrina nikkoensis;* B, *T. dearnessii;* C, *T. carveri;* D, *T. sebastianae;* E, *T. aesculi.*

94. *Taphrina carveri* Jenkins

Taphrina carveri Jenkins, Jour. Washington Acad. Sci. **29**:222-230. 1939.

Causing small, well defined black spots on leaves of *Acer saccharinum* L.

Mycelium subcuticular.

Asci hypophyllous, short-cylindric, rounded or truncate at the apex; stalk cells short, often broader than the ascus. Ascospores eight, round, ovate or elliptic, often budding in the ascus. (Fig. 38, C.)

Dimensions: Of *asci,* 23-53μ × 8-17μ; of *stalk cells,* 4-15μ × 10-22μ; of *spores,* 4.5-6μ × 3-5μ.

Distribution: Alabama, Missouri.

Material examined: ALABAMA: Tuskegee, April 30, 1897 (Ellis Herb. 17918). MISSOURI: Lutesville, May 30, 1941, A. J. M.; *ibid.,* June 3, 1942, L. Engelhart.

This fungus is very close indeed to *Taphrina dearnessii* on *Acer rubrum.* Perhaps the two species are identical.

HOST INDEX TO SPECIES OF *TAPHRINA* ON ACER

Acer campestre L.
  Taphrina acericola Massal.
Acer circinatum Pursh.
  Taphrina darkeri Mix
Acer diabolicum K. Koch. var. *purpurascens* Rehd.
  Taphrina nikkoensis Kus.
Acer grandidentatum Nutt.
  Taphrina bartholomaei (Dearn. and Barth.) Mix
Acer nigrum Michx.
  Taphrina sacchari Jenkins
Acer orientale L.
  Taphrina polyspora (Sorok.) Johans.
Acer platanoides L.
  Taphrina acerina Eliass.
Acer pseudoplatanus L.
  Taphrina pseudoplatani (Massal.) Jaap
Acer rubrum L.
  Taphrina dearnessii Jenkins
Acer saccharum Marsh.
  Taphrina sacchari Jenkins
Acer saccharinum L.
  Taphrina carveri Jenkins
Acer spicatum Lam.
  Taphrina letifera (Pk.) Sacc.
Acer tataricum L.
  Taphrina polyspora (Sorok.) Johans.

IX. SPECIES ON HIPPOCASTANACEAE

Aesculus

95. *Taphrina aesculi* (Patt.) Giesenhagen

Taphrina aesculi (Patt.) Giesenhagen, Flora **81**:267-361. 1895.
Exoascus aesculi Patterson, Bull. Lab. Nat. Hist. Univ. Iowa **3**:89-135. 1895.

Causing small to large, round to irregular, yellow-brown blighted areas on leaves of *Aesculus californica* Nutt. Affecting whole shoots and shoot-systems. Specimens seen have not been true witches' brooms.

Mycelium intercellular, in leaves and twigs.

Asci hypophyllous, epiphyllous, or amphigenous, rounded at the apex, stalk cell short, sometimes wider than the ascus. Ascospores eight, round, ovate, or elliptic, often budding in the ascus. (Fig. 38, E.)

Dimensions: Of *asci,* 20-38μ × 8-15μ; of *stalk cells,* 7-13μ × 10-23μ; of *spores,* 4-7μ × 4-5.5μ.

Distribution: California.

Material examined: CALIFORNIA: Glenn Co., near Elk Creek, May 15, 1938, H. Earl Thomas; Hopland, May 13, 1936, *id.;* Marin Co., Muir Woods, May 25, 1929, L. Bonar; Palo Alto, San Francisquito Creek, April 25, 1940, R. H. Thompson; *ibid.,* May 1, 1940, *id.; ibid.,* May 13, 1941, *id.*

X. SPECIES ON COMPOSITAE

Sebastiana

96. *Taphrina sebastianae* (Sadeb.) Jaczewski

Taphrina sebastianae (Sadeb.) Jaczewski, Pocket Key for Determination of Fungi. Part I. Exoascales. Leningrad. 1926.
Exoascus sebastianae Sadebeck, Ber. Deutsch. Bot. Ges. **22**:119-133. 1904.

Causing lesions whose nature cannot be determined from extant material (because of the presence of a rust-fungus) on leaves of *Sebastiana ypanemensis* (Mill.) Arg.

Mycelium of unknown habit.

Asci cylindric, rounded at the apex, stalk cells flattened or wedge-shaped below. Ascospores eight, round, ovate, or elliptic, often budding in the ascus. (Fig. 38, D.)

Dimensions: Of *asci,* 26-40μ × 13-18μ; of *stalk cells,* 7-13μ × 13-18μ; of *blastospores,* 4-5.5μ × 2-4μ.

Distribution: Brazil.

Material examined: Brazil: Santa Catharina, Tubarao, Nov. 1889, E. Ule [three collections: 1. E. Ule, Fungi botanicum Berolinense 1496, Type. 2. Ex. Herb. Sydow (in Bot. Mus Stockholm). 3. Herbarium Brasiliense 1495 (in Farl. Herb.)].

Sadebeck (1904), in describing this fungus, recorded a remarkable polymorphism of asci. All of the curious asci described and figured by him were apparently teliospores of a rust. They occur in all states: immature, mature, and germinating. The rust is abundant in all specimens examined and in the type specimens no asci are to be found. The asci were seen best in the specimens in the Stockholm Museum. They are typical *Taphrina*-asci as described above. Further collections of this fungus would be very desirable.

The labels of the type-collection and of the specimens in the Farlow Herbarium read: "*Exoascus Sebastianae* Sadeb. n. sp., *Uredo Sebastianae* Wint. n. sp."

XI. SPECIES ON ZINGIBERACEAE

Curcuma, Globba, Hedychium, Zingiber

97. *Taphrina maculans* Butler

Taphrina maculans Butler, Ann. Mycol. 9:36-39. 1911.

Causing small (up to 5 mm. diam.) yellow-brown, unthickened spots, (very numerous and crowded) on leaves of *Curcuma amada* Roxb., *C. angustifolia* Roxb., *C. longa* L., *Hedychium acuminatum* Wall., *Zingiber casumunar* Roxb., *Z. mioga* Rosc., *Z. berumbet* Rosc.

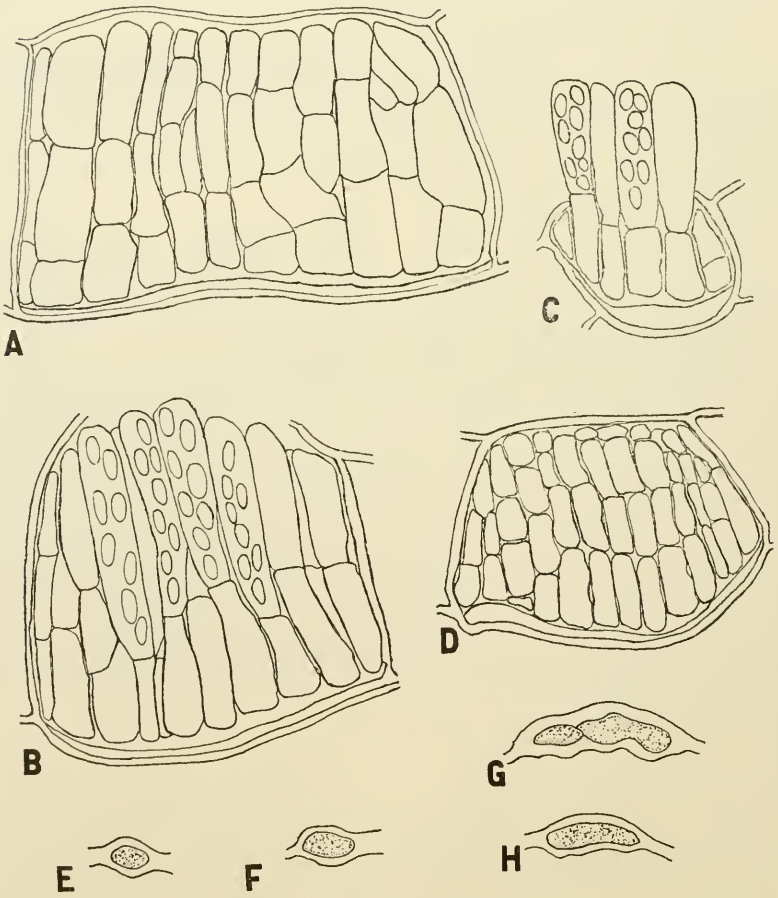

FIG. 39. A, ascogenous cells; B, asci of *Taphrina maculans;* C, asci; D, ascogenous cells of *T. linearis.* E-H, mycelium of *T. linearis* growing in the epidermal wall. All × 900.

Mycelium growing within epidermal walls and within radial walls between cells of epidermal and subepidermal layers, sometimes forming flat plates of hyphae, occasionally sending haustoria into host cells. (Fig. 39, A, C.)

Asci epiphyllous, clavate, rounded or truncate at the apex; stalk cell single or divided by septa into two or three cells; ascospores eight, round, ovate, or elliptic, sometimes budding in the ascus.

Dimensions: Of *asci,* 20-36μ × 6-10μ; of *stalk cells,* 10-17μ × 5-7μ; of *ascospores,* 4-6.5μ × 2-3.5μ.

Distribution: India, Japan.

Material examined: Curcuma amada. India: Sahranpur, Government Bot. Gardens, Nov. 17, 1903, W. Gollan.

C. angustifolia. Himalaya: Kumaon, Bageshwar, June 13, 1907, Inayat Khan.

C. longa. Bihar: Pusa, Aug., 1916, M. Taslim. Bombay Pres.: Hatkalangda, Dec. 15, 1910, G. S. Kulkarni.

Hedychium acuminatum. India: Nainital and Musscorie, Oct. 6, 1929, J. H. Mitter, A. K. Mitra, V. B. Singh.

Zingiber casumunar. India: Bengal, Rangpur, March 13, 1909, S. N. Mitra.

Z. mioga. Japan: Mutsu, Korekawa, Oct. 1, 1913, M. Miuma (Herb. Sydow, Bot. Mus. Stockholm).

Z. zerumbet. India: Bihar, Muzaffarpur, Awapur, Oct. 18, 1910, Jamal bux.

Most of these specimens are immature, and only rarely may mature asci be found.

98. *Taphrina linearis* Sydow and Sydow

Taphrina linearis Sydow and Sydow, Ann. Mycol. 12:545-576. 1914.

Causing small, elongate, red-brown spots or streaks on leaves of *Globba marantina* L.

Mycelium growing within the outer epidermal wall and within radial walls between cells of epidermal and hypodermal layers.

Asci clavate, rounded or truncate at the apex, each provided with one or a few stalk cells. (Fig. 39, B, D-H.)

Dimensions: Of *asci,* given by the authors as 25μ × 7-9μ; a few young asci seen by the writer measured 13-20μ × 6-8μ; of *ascospores,* 4-5μ × 3.5-4μ.

Distribution: Philippine Islands.

Material examined: Philippine Islands: Luzon, Bulacan, near Angat, Sept. 15, 1913, M. Ramos (F. Exot. Exs. 422. Three copies seen).

This material is, for the most part, immature.

XII. NONVALID AND EXCLUDED SPECIES

A. Described Species

1. *Exoascus anomalus* Saccardo, Sylloge Fungorum 8:820.
This is *Ascocorticium anomalum* Schroet.

2. *Taphrina candicans* Saccardo, Michelia 1:117-132. 1880.

This "fungus" was described by Saccardo as a doubtful species of *Taphrina* occurring on *Teucrium chamaedrys* L. A specimen exists in the Botanical Museum at Padua, and duplicates were issued (collected at Lyon, 1884) under this name as Roumeguére, Fungi selecti exsiccati 4499. The species was excluded from the genus by Giessenhagen (1895) and the specimen is said by Jaczewski (1926) to show the effect of mite-injury and no fungus.

3. *Taphrina cissi* Zollinger, Natur. et Genneeskund. Arch. Nederlands Indie 1:372-405, 2:1-19, 200-273, 563-587, 3:51-92. 1847.

This fungus was described as occurring on *Cissus varius*. A record and description of it is to be found in the Botanical Museum at Buitenzorg, but no specimen is known. It is not mentioned in the literature since Zollinger except for a copy of Zollinger's description in Saccardo, Sylloge Fungorum **10**:68.

4. *Ascomyces fulgens* Cooke and Harkness, Grevillea 9:6-9. 1880.
Exoascus fulgens (Cke. and Harkn.) Saccardo, Sylloge Fungorum 8:820.

This "fungus" was described by Cooke and Harkness as occurring on leaves of *Arctostaphylus pungens* HBK. It was later pronounced by Harkness (1886) to be an "aphidian gall."

5. *Exoascus marginatus* Lambotte and Fautrey. (Roumeguere, Fungi Exsicati Praecipue Gallici, 6228.)

This was described as occurring on leaves of *Crataegus oxyacantha* L. The specimens, collected Aug. 1892 by F. Fautrey, show only injury due to mites (Erineum).

6. *Taphrina rhaetica* Volkart, Ber. Deutsch. Bot. Ges. 21:477-481. 1903.

This fungus, described by Volkart as occurring on leaves of *Crepis blattarioides* Vill., was transferred by Juel (1902) to the genus *Taphridium* of the Protomycetaceae becoming *Taphridium volkartii* (Volkart) Juel.

7. *Taphrina umbelliferarum* Rostrup, Bot. Tidskr. 14:230-243. 1885.

The fungus, described by Rostrup as occurring on *Heracleum sphondylium* L. and *Peucedanum palustre* Moench., was transferred by Juel (1902) to the genus Taphridium, becoming *Taphridium umbelliferarum* (Rostr.) Lagerh. and Juel.

8. *Taphrina oreoselini* Massalongo, Nuov. Giorn. Bot. Ital. **21**:422-423. 1889.

Occurring on *Peucedanum oreoselinum* Moench., this fungus is apparently identical with the preceding and was renamed by Juel (l. c.) *Taphridium umbelliferarum.*

9. *Taphrina githaginis* Rostrup, Vidensk. Meddel. Natursk. Foren. Kjøbenhavn. **1890**:246-264. 1890.

This fungus, on *Agrostemma githago* L., from its description clearly belongs to *Taphridium.* Neger (1905) proposes its transfer to that genus, without, however, actually renaming it. Specimens have not been seen.

10. *Exoascus avellanae* Connold, Plant Galls of Great Britain. London. 1909.
Exoascus coryli Lemée, Bull. Soc. Hort. del Orne, Alencon. 1917.

No fungus having been seen in association with this witches' broom of *Corylus avellana,* Saccardo (Sylloge Fungorum **24**:1301) declared this binomial to be a nomen nudum.

11. *Taphrina randiae* Rehm, Hedwigia **40**:170. 1901.

This species, occurring on *Randia* sp., was named and described from a specimen collected at Serra Orgãos, Brazil, by E. Ule. It was reported as causing elliptic (1-2 cm. × 1.5-1 cm.) black spots thickened above. The asci were said to measure 50μ × 25μ, to lack a stalk cell, and to be polysporous. A portion of the type-specimen was received from the Berlin Botanical Museum as a gift. It consisted of part of a leaf which had been cut in two, the cut passing through a thickened black spot which appeared as described above. This spot contained acervuli but no asci. No mycelium characteristic of *Taphrina* could be found. The name *Taphrina randiae* thus becomes a *nomen dubium.* No attempt was made to identify the imperfect fungus.

12. *Exoascus uleanus* F. Hemmings, Hedwigia **43**:79-95. 1904.

This species has been fully discussed earlier in the section dealing with forms on ferns. As pointed out there no identifiable fungus can be found, either in the type specimen or in duplicates. The binomial becomes a *nomen dubium.*

13. *Exoascus theobromae* Ritzema Bos, Tijdschr. Plantenziekt. **6**:65-90. 1900.

In this paper Ritzema Bos described a witches' broom of *Theobroma cacao* L. occurring in Surinam. He stated that he found a few asci present, but could not, on account of the state of the material describe the fungus. Nevertheless he named it as above. Went (1904) studied the same material, finding mycelium present

but no asci, and was unable to decide whether the witches' broom was due to a species of *Taphrina*. Subsequently Faber (1908) declared *Exoascus theobromae* to be a *nomen nudum*.

According to Cook (1913) the witches' broom of cacao, said by Ritzema Bos to be caused by *Exoascus theobromae*, was later ascribed by Van Hall and Dorst to *Colletotrichum luxificum*.

14. *Taphrina bussei* Faber, Arb. K. Biol. Anst. Land und Forstw. 6:385-395. 1908.

This fungus was described by Faber as causing a witches' broom on *Theobroma cacao* L. The disease was found in Kamerun, and was held to be distinct from the witches' broom of Surinam (see above). The fungus was said to have asci 15-17μ × 5μ and spores 2.5μ × 1.7μ. No mention was made of a stalk cell but the asci shown in Faber's figure seem to be borne on the ends of septate hyphae. The fine mycelium described and figured is intracellular.

This fungus has not received further mention in the literature. Dr. von Schoenau, then chief curator of the Munich Botanical Museum, wrote in 1938 that he had been informed by Faber that the type-material of *Taphrina bussei* had been placed in the herbarium of the Biologische Reichsanstalt für Land-und Forstwistschaft in Berlin, but that a thorough search instituted there in response to his inquiry had failed to reveal it.

According to Ludwigs (1934), this witches' broom (which should be rather called "overbranching") is due to adverse environmental factors and not to any parasite.

B. Species named but never described

1. *Exoascus quercus-lobatae* Mayr, Die Waldungen von Nordamerika etc. Munich. 1889.

This name, unaccompanied by any description, was given to a supposed fungus causing a witches' broom on *Quercus lobata* Née. It is clear from Mayr's account that he never saw any fungus and the cause of the witches' broom remains unknown. *Taphrina caerulescens* does occur on this host.

2. *Taphrina fagi* Lamb. (See account given earlier in this paper.)

3. "*Exoascus* or *Taphrina*" on Fuschia. São Leopoldo, Rio Grande do Sul. 1905. Rick, Fungi Austro Americani 78.

Three packets of this collection are in the Farlow Herbarium, two of them from the herbarium of F. Theissen. No *Taphrina* is present.

4. "*Exoascus Taphrina in Myrtacea.*" São Leopoldo, Rio Grande do Sul, 1929. Rick, Expeditions in Brazil. In Farlow Herbarium.

These specimens have an appearance suggesting mite injury. No *Taphrina* is present.

5. "*Exoascus Tradescantiae,*" São Leopoldo, Rio Grande do Sul. Rick, Expeditions in Brazil. In Farlow Herbarium.
Acervuli are present, but no *Taphrina*.

6. "*Exoascus Symploci* E. and E." on *Symplocus tinctoria,* Coöpolis, Mississippi, April 24, 1898. S. M. Tracy. Farlow Herbarium, 5326, Herb. S. M. Tracy.

Specimens are of greatly deformed structures, perhaps fruits. A fungus is present but is not determinable.

7. "*Taphrina selaginellae* P. Hennings ad int." on *Selaginella menziesii* Hook. and Gr., Hawaii: Molokai, Pali of Kalanpapa from Kalae. W. Hillebrand. In Mus. Bot. Berlin (in 1938).

This fungus is mentioned by Laubert (1928). Specimens obtained from the Berlin Museum consisted of one healthy and one diseased shoot. The latter was dwarfed, with closely appressed, partially developed scales. It was pale green to brownish and bore a number of small brown spots covered with a white bloom. The fungus present was a Hyphomycete with spores about the size of those of *Taphrina*. No asci could be found and the slender hyphae were intracellular.

8. "*Exoascus* sp., Taches bullaties sulres feuilles de *Alnus acuminata* o' *A. ferruginea* are Carrio Amon a' San Jose." Jan., 1913. A. Tonduz. Mus. Nac. de Costa Rica 164. In Farlow Herbarium.
Perhaps insect injury. No *Taphrina*.

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A Preliminary Account of the Herpetology of the State of San Luis Potosí, México

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ABSTRACT: A herpetological collection belonging to the Louisiana State University, acquired through the efforts of Mr. and Mrs. Robert Newman and Charles R. Shaw in the State of San Luis Potosí, México, is reviewed in some detail. Two amphibians, ten lizards, and twenty-three snakes are added to the known fauna. One new snake genus, *Schmidtophis,* and the following new species are described: *Xenosaurus newmanorum,* a lizard of the family Xenosauridae; and three colubrid snakes, *Schmidtophis rubriventris, Rhadinaea marcellae* and *Tantilla shawi.*

Under the immediate direction of Mr. George Lowery, the University of Louisiana has for several years been pursuing a study of the avian fauna of the state of San Luis Potosí, México. Several field parties have been stationed there at various times, and while their primary interests have been directed toward the collecting of birds, nevertheless numerous specimens of other vertebrate groups have been taken.

The most recent field party (1946-1947), consisting of Mr. Robert J. Newman, his wife, Marcella Newman, and Mr. Charles R. Shaw, were requested to obtain a representative lot of the herpetological fauna. This task fell largely to Mrs. Newman, who succeeded in collecting or acquiring more than 300 specimens. Aside from these, there are thirty-five specimens taken by Mr. Robert J. Newman and forty-four by Mr. Charles R. Shaw.

The collection is of especial importance, since the San Luis Potosí area had been largely neglected by earlier collectors, and in the recent herpetological explorations of Dr. Hobart M. Smith and me in Mexico no intensive collecting was done in any part of this state. Our journeys, however, have taken us across the eastern part of the state several times; once across the western part, and on one trip I

journeyed from the eastern part through the central plains area to the capital. Thus, a number of specimen records were obtained.

Three Mexican biotic provinces (delineated by Dr. Hobart M. Smith on the basis of herpetological data) include portions of the state. The Austro-central, which takes in the drier, western two-thirds of the state; the Austro-oriental, which includes most of the highlands of the eastern part; and a small lowland eastern area belonging in the Veracruzian province.

The known herpetological fauna of the state is listed herewith:

SNAKES

Leptotyphlops humilis tenuiculus
Leptotyphlops myopicus myopicus
Constrictor constrictor imperator
Conopsis nasus
Diadophis regalis laetus
Drymarchon corais erebennus
Drymobius margaritiferus margaritiferus
Elaphe chlorosoma
Geophis latifrontalis
Heterodon nasicus kennerlyi
Hypsiglena ochrorhyncha ochrorhyncha
Hypsiglena ochrorhyncha janii
Lampropeltis mexicana
Leptodeira annulata septentrionalis
Leptodeira maculata
Thalerophis mexicanus mexicanus
Masticophis flagellum lineatulus
Masticophis flagellum testaceus
Masticophis mentovarius mentovarius
Masticophis taeniatus australis
Masticophis taeniatus ruthveni
Oxybelis potosiensis
Pituophis deppei deppei
Pseustes poecilonotus argus
Rhadinaea crassa
Rhadinaea gaigeae
Salvadora lineata
Spilotes pullatus mexicanus
Tantilla atriceps
Tantilla deviatrix
Tantilla rubra
Tantilla wilcoxi rubricata
Toluca lineata lineata
Tropidodipsas sartorii sartorii
Natrix rhombifera blanchardi
Storeria dekayi texana
Storeria dekayi temporalineata
Storeria hidalgoensis
Storeria storerioides
Thamnophis eques cyrtopsis
Thamnophis macrostemma megalops
Thamnophis melanogaster canescens
Thamnophis sauritus proximus
Thamnophis scalaris scaliger
Micrurus fitzingeri microgalbineus
Bothrops atrox asper
Crotalus atrox
Crotalus lepidus lepidus
Crotalus molossus nigrescens
Crotalus scutulatus scutulatus
Crotalus triseriatus triseriatus

LIZARDS

Crotaphytus collaris collaris?
Ctenosaurus acanthura
Sceloporus cautus
Sceloporus ferrariperezi melanogaster
Sceloporus goldmani
Sceloporus jarrovii minor
Sceloporus microlepidotus disparilis
Sceloporus parvus parvus
Sceloporus parvus scutulatus
Sceloporus spinosus spinosus

Sceloporus variabilis variabilis
Phrynosoma modestum
Phrynosoma cornutum
Phrynosoma orbiculare var.
Holbrookia texana
Ameiva undulata podarga
Cnemidophorus gularis gularis
Cnemidophorus perplexus
Barisia imbricatus ciliaris
Anelytropsis papillosus
Eumeces lynxe lynxe
Eumeces tetragrammus

TURTLES

Kinosternon integrum
Terrapene mexicana
Gopherus berlandieri

AMPHIBIANS

Diemictylus kallerti
Bolitoglossa rufescens
Bolitoglossa platydactyla
Chiropterotriton multidentata
Scaphiopus couchii
Scaphiopus multiplicatus
Bufo cognatus
Bufo horribilis
Bufo valliceps
Bufo punctatus
Tomodactylus macrotympanum
Syrrhophus guttilatus
Syrrhophus latodactylus
Syrrhophus cystignathoides
Syrrhophus campi
Leptodactylus melanonotus
Leptodactylus labialis
Eleutherodactylus latrans
Eleutherodactylus rhodopis
Acrodytes spilomma
Smilisca baudinii baudinii
Hyla eximia
Hyla picta
Hyla staufferi
Hyla arenicolor
Hyla miotympanum
Hypopachus cuneus cuneus
Rana pipiens

The present collection contains numerous species that here are traced to this area for the first time. The following represent new records for the State of San Luis Potosí.

Pseudoeurycea bellii
Eleutherodactylus hidalgoensis
Anolis sericeus
Anolis petersii
Corythophanes hernandesii
Laemanctus serratus
Crotaphytus collaris baileyi
Holbrookia maculata approximans
Sceloporus jarrovii immucronatus
Sceloporus serrifer plioporus
Sceloporus olivaceus
Gerrhonotus liocephalus loweryi
Adelphicos quadrivirgatus quadrivirgatus
Ficimia streckeri
Geophis multitorques
Ninia diademata plorator
Rhadinaea decorata
Dryadophis melanolomus veraecrucis
Drymarchon corais erebennus
Pituophis deppei jani
Lampropeltis triangulum arcifera
Lampropeltis triangulum polyzona
Elaphe flavirufa flavirufa
Elaphe laeta laeta
Pliocercus laticollaris
Thamnophis phenax phenax
Thamnophis marciana
Coniophanes imperialis imperialis
Coniophanes fissidens proterops
Trimorphodon tau
Bothrops nummifer

There is a possibility that the species formerly reported from the State as *Crotaphytus collaris collaris* is identical with the one here referred to *C. collaris baileyi.*

The forms described as new are:

Xenosaurus newmanorum
Schmidtophis
Schmidtophis rubriventris
Rhadinaea marcellae
Tantilla shawi

A few specimens in the collection will be treated at a later time.

The larger part of the specimens were collected in the area about the town of Xilitla which lies in the southeastern part of the State of San Luis Potosí a few miles from the border of the State of Hidalgo and equally close to the border of Querétaro. Some of the mountains in this region exceed an elevation of 7,000 feet. A few of the specimens come from this elevation on Cerro Coneja. The greater part of the specimens, however, are from elevations between 2,000 and 3,000 feet.

Mrs. Newman was successful in interesting the townspeople in the collection and many specimens were brought to her by farmers, school children and others. This procedure made it almost impossible to obtain accurate elevation data. The surprising character of the collection is the far greater proportion of snakes to the amphibians and lizards than is usual in such a collection.

CAUDATA

Only one species of salamander, *Bolitoglossa platydactyla* (Gray), is represented in the collection by a numbered specimen. From the stomachs of certain snakes in the collection four other species have been taken, but it has not been possible, in all cases, to ascertain the complete identity of these.

Three of these came from snakes of the genus *Thamnophis.* These are *Thamnophis scalaris scaliger, T. marciana,* and *T. phenops phenops.* The fourth specimen came from the stomach of an aberrant rattlesnake referred to *Crotalus triseriatus triseriatus.*

Four species of salamanders have previously been found within the state limits. These are *Diemyctylus kallerti* Wolterstorff, *Bolitoglossa rufescens* (Cope), *Bolitoglossa platydactyla* (Gray), and *Chiropterotriton multidentata* (Taylor).

Diemyctylus kallerti Wolterstorff

Diemyctylus kallerti Wolterstorff, Abh. Ber. Mus. Magdeburg, vol. 6, 1930, pp. 147-149, pl. 3, fig. 1; text figs. 12, 13. (Type locality, Tampico, Veracruz.)

This species, known from Tampico, Veracruz, and from Villa Juarez, San Luis Potosí, has remained very rare in collections. A

specimen, consisting of a head, more or less intact, together with the partly digested remains of the body and limbs, was recovered from the stomach of a snake, *Thamnophis marciana* (Baird and Girard), which was taken 6.5 miles east of Sabanito, San Luis Potosí.

The generic identification was made on the characters of the head, especially the teeth, choanae, and on the character of the vertebrae. The specific identification is largely on the basis of probability, since *D. kallerti* is the only species of the genus known from this area, and the few characters exhibited agree. I have no doubt that it is correctly identified with that species.

Pseudoeurycea bellii (Baird)

Oedipus platydactylus Baird, Journ. Acad. Nat. Sci. Philadelphia, ser. 2, vol. 1, 1849, p. 286 (*nec Salamandra platydactylus* Cuvier). (Type locality, México.)

Spelerpes bellii Gray, Catalogue of the Batrachia gradientia of the British Museum, 1850, p. 46.

Pseudoeurycea bellii Taylor, Univ. Kansas Sci. Bull., vol. 30, 1944, p. 209.

A partly digested specimen of this species was taken from the stomach of *Thamnophis scalaris scaliger* (Jan). The characteristic red color markings of head and body identify this species without question. The snake is no. 293 from the Xilitla region and is mentioned elsewhere in the paper under its name. This is a new record of *P. bellii* for the state and the most northerly record on the eastern part of the plateau.

Bolitoglossa platydactyla (Gray)

Salamandra platydactylus Gray, Supplement, in Griffith and Pidgeon's Cuvier's, The Animal Kingdom, vol. 9, 1931, p. 107. (Type locality, México.)

Bolitoglossa platydactyla Taylor, Univ. Kansas Sci. Bull., vol. 30, 1944, p. 219.

The single specimen in the collection (no. 525) comes from the Xilitla region. It displays all the usual characteristics of this species. The dorsal coloration is uniform brownish-faun, with an elongate, V-shaped, dark mark on the head and neck, followed by four or five irregularly-placed dark flecks.

I suspect that this specimen came from a much lower elevation than that of the town of Xilitla (2,200 ft.), since the species is not known to occur much above 2,000 feet elevation.

Chiropterotriton sp.

A salamander taken from the stomach of no. 285, a young *Thamnophus phenax phenax* Cope, has the anterior part of the body more or less intact, save that the tips of the toes have the terminal pads missing, leaving the terminal bones exposed.

The following characters are evident: maxillary teeth 30-30, sub-

equal in size; premaxillary teeth, 8; vomerine teeth, 7-7, the series beginning on the inner edge of the choanae; separated from each other posteriorly by a distance equal to the narrowest diameter of choanae, and from the palatine series by a distance equal to two-thirds of the distance between choanae. Mandibular teeth 34-34.

First finger completely involved in web; others with small web at base, leaving 2½ phalanges free. The costal grooves are 13. The median part of the venter is without pigment; some pigment is present on the chin.

Most of the other external characters are obscured by the process of digestion, which makes specific identification uncertain. The teeth are somewhat more numerous than in *Chiropterotriton multidentata* Taylor. However, it is with this species that the form must be compared. Not impossibly it represents an undescribed form.

SALIENTIA

Bufo horribilis Wiegmann

Bufo horribilis Wiegmann, Isis von Oken, vol. 26, 1833, pp. 654-655. (Type locality, Misantla and Veracruz, Veracruz, México.)

A young specimen (no. 527) was taken by Charles R. Shaw 3 miles north of Pujal, San Luis Potosí.

Bufo valliceps Wiegmann

Bufo valliceps Wiegmann, Isis von Oken, vol. 26, 1833, pp. 657-659. (Type locality, México.)

A series of 33 specimens was collected (nos. 439-471), chiefly in April, May and June of 1947, although two specimens were found as early as March 5 of the same year.

Most of the specimens conform to the typical characters and color patterns of the species. Three, however (nos. 441, 456, and 459), large gravid females, are of a very dark blackish color, lacking almost all trace of the typical color pattern of the other specimens.

Melanism has not been observed in other populations of this widespread species.

Syrrhophus sp.

Two specimens of this genus are in the collection but unfortunately both are in poor condition. One, no. 533, "found drowned in a thunder-jug" is bloated and surface tissues are somewhat softened and rotted. Consequently, some of the features, such as color markings and skin characters, can be only doubtfully interpreted. The second (no. 534), completely dried and shrivelled before being placed in alcohol, likewise is difficult to identify.

The species belongs in the section of the genus in which a tiny outer palmar tubercle is present, and the terminal pads on outer fingers are distinctly wider than the digits. The choanae are small, the diameter of one contained in the distance between them, five to six times. One cannot be certain whether a web vestige is present or not or whether the skin of the venter is areolate. The diameter of the tympanum is about two thirds the diameter of the eye and the eyelid is granular. The identity of the species is in question. For one reason or another the following species of *Syrrhophus* in this section can be eliminated: *latodactylus, verruculatus, campi, guttilatus, smithi,* and *leprus.* If the specimens belong to a known species, they are referrable to *cystingnathoides* or *verrucipes* with the greater probability to *verrucipes.*

Three species are already known from the state. These are *Syrrhophus guttilatus, S. latodactylus* and *S. campi. S. cystignathoides* has been reported with a question.

Eleutherodactylus hidalgoensis Taylor

Eleutherodactylus hidalgoensis Taylor, Univ. Kansas Sci. Bull., vol. 28, pt. 2, 1942, pp. 299-301, pl. 25, figs. 5-8; pl. 27, fig. 10.

This rare species has been known previously from two small male specimens from near Tianguistengo, Hidalgo. Fortunately the collection contains three specimens, two large females and one male, all taken in a cave near Xilitla by Charles Shaw.

These specimens differ from the types in only small details. In the two larger females, the head while proportionally the same, shows no indefinite occipital fold, and the tympani of the females are somewhat larger—more than half of the diameter of the eye. The tympanum in the male is practically as in the type. On the tarsus the inner fold is distinct and continuous in the large females, indistinct in the male, and the tubercles on the outer side are faintly indicated in the females and are not discernible in the male.

The color (in formalin transferred to alcohol) of no. 523 is gray with some darker gray flecks. The tympanum is brown with a lighter center. The snout and head are darker gray, with a faint light interorbital line and two indistinct lighter diagonal lines or bars behind eyes tending to inclose a darker triangle. The barring on limbs is indistinct, the color dark gray. No. 524 is lavender to purplish brown. The head pattern is discernible but indistinct, and the back is clouded with darker. The bars on the limbs are more distinct than in the type. In the male (no. 525) the w-shaped pattern of the type is more plainly visible and the head markings are

likewise very distinct. The back is clouded or flecked with brown. All of these three specimens are light flesh on the ventral surfaces but there is a peppering of pigment visible under the lens.

The finding of these specimens in a cave is of great interest. It is possible that crevices in rocks and caves, rather than trees, are the normal habitat of the species and may account for the fact that only a few specimens have been found.

Smilisca baudinii baudinii Duméril and Bibron

Hyla baudinii Duméril and Bibron, Erpétologie générale ou histoire naturelle complète des reptiles, vol. 8, 1841, pp. 564-5. (Type locality, México.)

Hyla baudinii baudinii Stejneger and Barbour, Checklist of North American Reptiles and Amphibia, 2d ed., 1923, p. 29.

Smilisca daulinia Cope, Proc. Acad. Nat. Sci. Philadelphia, vol. 17, 1865, Oct., p. 65; footnote (=*Hyla baudinii*).

A series of 19 specimens (nos. 505-522, 532) was collected in May and June of 1947. The earliest date is May 9, and the latest June 25. Many of these are gravid females. All were taken in the Xilitla region or (one) "on the road to Xilitla."

Acrodytes spilomma Cope

Hyla spilomma Cope, Proc. American Phil. Soc., vol. 17, July 20, 1887, p. 86. (Type locality, Cosomoloapam, Veracruz, México.)

Acrodytes spilomma Smith and Taylor, Univ. Kansas Sci. Bull., vol. 30, 1944, p. 64.

A single small specimen (no. 531) belonging to this species was obtained at Pujal, November 21, 1946, by Charles R. Shaw. The dorsal coloration is brown with rather broad cream lines beginning behind the eye and extending back dorsolaterally about two-thirds the length of the body. The limbs are lighter than the body, with black flecks on the numerous pustules. It was found on a cornstalk.

Specimens have previously been reported from Río Coy (near Pujal) and Tamazunchale, in San Luis Potosí.

Hyla miotympanum Cope

Hyla miotympanum Cope, Proc. Acad. Nat. Sci. Philadelphia, vol. 18, Mar., 1863, p. 47. (Type locality, near Jalapa and Mirador, Veracruz, México.)

A gravid female (no. 529), taken at Xilitla, is in the collection. It differs from more typical specimens in having the tympanum nearly half the diameter of the eye, while the typical form usually has the tympanum only one third to one fourth the eye diameter.

There is a slight axillary web, and the first finger is opposed to the other three. A continuous inner tarsal fold is present.

Specimens have previously been reported from Tamuzunchale and Valles.

Hyla arenicolor Cope

Hyla affinis Baird, Proc. Acad. Nat. Sci. Philadelphia, vol. 7, Apr., 1854, p. 61 (*nec Hyla affinis* Spix, 1854). (Type locality, northern Sonora, México.)

Hyla arenicolor Cope, Journ. Acad. Nat. Sci. Philadelphia, ser. 2, vol. 6, July, 1866, p. 64 (substitute name for the preceding species).

A single specimen (no. 528) was obtained by Robert Newman at the San Luis Potosí Reservoir, March 28, 1947.

The specimen is ash gray with darker blotches. Specimens have been previously reported from the state.

Rana pipiens Schreber

Rana pipiens Schreber, Der Naturforscher, Halle, vol. 18, 1872, p. 185, pl. 4. (Type locality, Raccoon, Gloucester County, New Jersey, U. S. A.)

This widespread species is represented in Mexico by several forms which may well be worthy of subspecific recognition. However, no attempt has been made to allocate subspecifically a juvenile specimen in the collection (no. 530) taken at Villa del Reyes, San Luis Potosí.

SAURIA

Anolis sericeus Hallowell

Anolis sericeus, Hallowell Proc. Acad. Nat. Sci. Philadelphia, 1856, pp. 227-228. (El Encero de Jalapa, Veracruz.)

Seven specimens of this small anole are in the collection (nos. 561-567). Three of these have the two orbital series separated by an intercalated series of small scales. Four specimens have them separated save for one scale, which is in contact with its fellow. Four are males with an ample gular appendage bearing a dark red brown spot (said to be blue in life). The median portion of the appendage is whitish.

This is a new record for the state.

Anolis petersii Bocourt

Anolis petersii Bocourt, Mission Scientifique aux Mexique el dans l'Amérique Centrale; Etudes sur les Reptiles et les Batraciens, Livr. 2, 1873, pp. 79-80, pl. 13, fig. 2; pl. 15, figs. 11, 11a. (Type locality "la haute Vera Paz [Guatemala]"); Boulenger, Catalogue of the Lizards in the British Museum, 2d ed., vol. 2, 1885, pp. 66-67 (México).

Anolis biporcatus (non Wiegmann) Cope, Proc. Acad. Nat. Sci. Philadelphia, 1871, p. 215 (México).

A single specimen, no. 560, was captured in the Xilitla region. This form is rare in collections probably due to its habitat in forest trees. It is the largest Mexican species of the genus *Anolis*.

The specimen, a young adult, measures 93 mm. snout-to-vent. The type specimen is considerably larger, measuring 118 mm. This is the first record for the state.

Corythophanes hernandesii (Gray)

Chamaeleopsis Hernandezii Gray, Synops. Rept. in Griffith's Cuvier's Animal Kingdom, vol. 9, 1831, p. 45.

Corythophanes hernandesii Boulenger, Catalogue of the Lizards in the British Museum, 2d ed., vol. 2, 1885, p. 103.

A splendid series (nos. 407-438) of this rare casque-headed lizard with a horizontal spine above the ear, was obtained by Mrs. Newman in the Xilitla region. Two specimens, nos. 413 and 414, are from the specific locality, Rancho Apetsco.

The specimens agree in structural detail with Boulenger's decription (*loc. cit.*). However, there is variation in coloration between the two sexes. Females have the sides of the snout light while the eye is involved in a broad diagonal black line that reaches to the edge of the tympanum. Three lines begin from lower edge of the black stripe, and pass down across the jaws and then are deflected backwards to breast. The bellies are usually banded with lighter and darker brown, the latter may be broken into discrete spots. Sides of head casque dark. One dark band on shoulder and four more or less distinct short dorsal bands. The one on the rump is more conspicuous than the others.

Males often have the black diagonal stripe involving eye, bordered below with white. The sides of snout and entire lower jaw, throat, and to a lesser extent the abdomen, light. A small protruding throat fan evident in males (to a somewhat lesser extent in females). The sides of the casque are reddish brown with some black reticulation.

Laemanctus serratus Cope

Laemanctus longipes (non Wiegmann) Duméril, Arch. Mus., vol. 8, 1856, p. 512, pl. 21, fig. 4; Bocourt, Arch. Mus., vol. 8, p. 114, pl. 17, fig. 4.

Laemanctus serratus Cope, Proc. Acad. Nat. Sci. Philadelphia, 1864, p. 176. (Type locality, not stated, presumably México); Boulenger, Bull. Soc. Zool. France, 1877, p. 463, pl. 7, fig. 3; Catalogue of the Lizards of the British Museum, 2d ed., vol. 2, 1885, pp. 104-105.

Three splendid specimens of this bizarre species are in the collection (nos. 337-339) taken at Xilitla by Marcella Newman. This species has remained exceedingly rare in collections. In the extensive collections made by Dr. Hobart M. Smith and me over a period of years not a single specimen was taken. It is not known whether the species is actually rare or only seemingly so. Its tree habitat and green coloration in life would prevent easy observation and acquisition by collectors.

Between the semicircular orbital series and the superciliary edge there are about six rows of smaller unequal scales. The parietal

area is constricted somewhat behind the orbits, and the lateral serrate edges of the casque come together posteriorly at an angle. The scales of the serrate edge are striate while all other scales are strongly rugose or tubercular. A series of regular plates on the snout between the two series of canthal scales extend back to the level of the eyes. Despite the fact that the nasal is moved back and separated by one or two scales from the rostral, the two most anterior of these may be interpreted as a pair of internasals in contact mesially with each other, with the rostral anteriorly and with a median azygos frontonasal posteriorly. The latter scale is bounded laterally by two supranasal scales, the most anterior of which is in contact with the internasals. The frontonasal is followed by a pair of prefrontals. Although the supraorbital areas are not elevated, each is bounded by a curved series of eight somewhat enlarged scales, the two series normally separated by a single series of scales (one specimen has two immediately following the prefrontals).

The limbs are extremely long; the adpressed hind limb reaches beyond the tip of the snout. The subdigital lamellae have rounded blackish, horny knobs, usually in a single series but under the joints there may be one or more pairs. Two elongate keels appear on the enlarged scales following the claws.

In life the specimens were nearly uniform green, save for the white stripe from eye to shoulder, bordered above by a broad dark line which narrows posteriorly. A series of brown spots are present on the sutures between the labials, and a white stripe runs from axilla to groin on the ventrolateral line. The tail is green but the shade is a rather grayish green.

In two of the preserved specimens the green color is completely gone, and is replaced by a reddish brown on the back and sides, on which is superimposed five irregular diagonal blotches, each joining its fellow on the back, the spots outlined in black or brown color. The chin is flecked with red brown. The tail is indefinitely banded with darker. The labials have a bluish cast, while the chin and venter are reddish purple with some greenish blue evident midventrally, and posterior to the anus. A cream-white line runs from under the eye to the shoulder and a cream spot or line is present on the side of the neck, both of which are parallelled by a darker stripe. The ventrolateral white stripe (partly discontinued) is present on the ventrolateral surface.

The third specimen which has undergone a different preservation in a heavy salt brine has retained most of its life colors.

Ctenosaura acanthura (Shaw)

Lacerta acanthura Shaw, General Zoology, vol. 3, pl. 1, 1802, p. 216. (Type locality [restricted to] Tampico, Tamaulipas, México.)

Ctenosaura acanthura Sumichrast, Arch. Sci. Phys. Nat., vol. 10, pp. 49-50; Bailey, Proc. U. S. Nat. Mus., vol. 73, art. 12, 1928, pp. 9-16, pls. 3, 4.

Two specimens, a young (no. 344), and an adult (no. 345), are in the collection from Ebano, San Luis Potosí.

The male is very dark, and little trace of the dorsal pattern remains. The dorsal crest is from 8 to 13 mm. high, extending from the back of the occiput to a point slightly back of the level of the thigh. The spiny whorls of the tail are separated by three smooth rows, at base (for 2 or 3 whorls) and by two for nearly half the length. Beyond this point there is little differentiation in the transverse rows. The femoral pores are 7-6.

Crotaphytus collaris baileyi (Stejneger)

Crotaphytus baileyi Stejneger, N. American Fauna, no. 3, 1890, p. 103, pl. 12, fig. 1. (Type locality, Painted Desert, Arizona.)

One specimen, no. 336, is from Presa de Gaudelupe, S. L. P.

The species of *Crotaphytus* occurring in Eastern San Luis Potosí appears to agree more closely with the southwestern *C. collaris baileyi* rather than with *C. collaris collaris* which is the expected eastern species. However, it differs from *C. baileyi* in the following characters: The median scales between the supraocular areas are in two enlarged series which are almost completely separated by an intercalated series of scales. Only two pairs of scales touch for a part of their length; normally three or four pairs are in contact for their entire length.

The head is grayish or clay color with small black dots scattered on the top and sides. A double black collar is present, the anterior part formed by a series of dots. The posterior part is continuous on each side, but above is interrupted mesially. About six dim, narrow, light, transverse bars are present on the back, the intervening areas being dotted with rounded dim, gray spots. Between the shoulders there is a transverse row of contiguous black dots; two other rows across the back, the black dots in these, however, are separate and not especially distinct. The chin is clouded or mottled with gray and dull cream; the underside of the abdomen, and the underside of the hands and feet are a uniform creamy white. The tail is bluish gray with numerous small rounded darker spots.

Should the character of the intercalated median scale row on the head prove constant in a series, this lizard might well be recognized as a new form.

Holbrookia maculata approximans Baird

Holbrookia approximans Baird, Proc. Acad. Nat. Sci. Philadelphia, 1858, p. 253. (Type locality, "Lower Rio Grande.")
Holbrookia maculata approximans Stejneger, N. American Fauna, no. 3, 1890, p. 109.

A specimen, no. 340, was captured five miles NE of Cándido Navarro, and no. 574 near the city of San Luis Potosí.

The specimens appear to be typical and extend the known range of the species from Central Chihuahua and Coahuila considerably farther to the southeast.

Sceloporus jarrovii immucronatus Smith

Sceloporus jarrovii immucronatus Smith, Copeia, 1936, pp. 223-227. (Type locality "Ten miles north of El Pinalito, Hidalgo, México.)

Six specimens of this form (nos. 548-533) were taken in the general area of Pendencia and Ciudad Maiz in eastern San Luis Potosí (the elevation of no. 548 is 4,300 ft., two miles south of the village of Pendencia.) The specimens, while agreeing in most characters, do differ to some extent.

These constitute the first record of this subspecies in the state, although *Sceloporus jarrovii minor* is known to occur in the western part. This latter form is characterized by a wide black nuchal collar, six to eight scales broad. In this series the collars are only three or four scales broad. The head and neck of the females have numerous bluish white spots.

Sceloporus serrifer plioporus Smith

Sceloporus serrifer plioporus Smith, Field Mus. Nat. Hist. Zool. ser., vol. 26, July 27, 1939, pp. 212-214. (Type locality, Encero, Veracruz.)

A specimen from Ebano, no. 547, is referred to this form despite certain differences from the type. It is a male and somewhat discolored by formalin. The femoral pores are 10-11, and there are 32 scales from occiput to above vent. The posterior frontal is divided longitudinally and separated from the interparietal.

The nuchal collar is about four scales wide and bordered behind by a narrow light collar. A few lighter marks are present on head and neck; the dorsal scales are normally mucronate. The tail has about seven bluish bands separated by darker bands. The field notes state: "back pale green and yellow; blue on sides of belly."

While this is the first record for the state, it is known from southern Tamaulipas and northern Veracruz.

Sceloporus spinosus spinosus Wiegmann

Sceloporus spinosus Wiegmann, Isis, vol. 21, 1828, p. 370.
Sceloporus spinosus spinosus Martín del Campo, Anales Inst. Biol., México, vol. 8, 1937. p. 262; Smith, Field Mus. Nat. Hist., Zool. Ser., vol. 26, 1939, pp. 87-94, fig. 10.

One female specimen, no. 554, taken in the Charcas Region, in an arroyo near Charcas Mine, 6,900 ft. elevation, is referred to this species.

Sceloporus olivaceus Smith

Sceloporus olivaceus Smith, Trans. Kansas Acad. Sci., vol. 37, 1934, pp. 263, 277-279; and Smith, Field Mus. Nat. Hist., Zool. Ser., vol. 26, 1939, pp. 110-118, pl. 13.

A large male, no. 555, from near Pendencia is referred to this species. There are five supraoculars and the prefrontals are separated; the large bluish marks are separated mesially by an elongate light stripe divided by a very thin black line; the bluish spots themselves have some indefinite dark markings; and the dorsolateral light stripes are more or less distinct.

The scales of the head are black with narrow, greenish, transverse markings. One line crosses the prefrontals, one crosses the supraoculars and another discontinuous line crosses the parietals. The superciliary area has six or seven small greenish spots. Three definite greenish lines run from the eye down across the labials.

Sceloporus microlepidotus disparilis (Stejneger)

Sceloporus disparilis Stejneger, Proc. Biol. Soc. Washington, vol. 29, 1916, pp. 227-230. (Type locality, Lomita Ranch 6 mi. N, Hidalgo, Texas.)
Sceloporus microlepidotus disparilis Dunn, Proc. Acad. Nat. Sci. Philadelphia, vol. 88, 1936, p. 472.

The single specimen (no. 342) from Xilitla is a male having the femoral pores, 16-16; 68 dorsal scale rows from the parietal to the posterior line of the thighs; and 67 scale rows around the middle of the body.

The species has been reported previously from several localities in the state.

Sceloporus variabilis variabilis Wiegmann

Sceloporus variabilis Wiegmann, Herpetologia Mexicana, 1834, p. 51. (Type locality México, by inference.)
Sceloporus variabilis variabilis Smith, Proc. Biol. Soc. Washington, vol. 47, pp. 127-129.

This is one of the most common lizards of the northern edge of the plateau, and is represented by a large series of specimens (nos. 346-406 and 568-576). Of these 14 are from Ebano, 1 from 2½ miles south of Pendencia, while the remainder are from the Xilitla region. The species appears to remain active throughout the winter. In

November, 14 were taken; December, 1; January, 5; February, 3; March, 2; April, 28; and May, 18.

Specimens from Ebano and Pendencia have the femoral pores small, and the rim of the pore scale is broken posteriorly. Those from Xilitla have the pores twice as large as the Ebano specimens and the rim of the scale surrounding the pore is usually unbroken.

Cnemidophorus gularis gularis (Baird and Girard)

Cnemidophorus gularis Baird and Girard, Proc. Acad. Nat. Sci. Philadelphia, 1852, p. 128 ("Indianola and the Valley of the Rio Grande del Norte").
Cnemidophorus gularis gularis Cope, Proc. Acad. Nat. Sci. Philadelphia, 1892, p. 334.

The subspecies *Cnemidophorus gularis gularis* is represented by six specimens (nos. 535-540) as follows: four from Ebano, one from the "Charcas Region, desert at Morelos Mine," and one from the "San Luis Potosí Reservoir."

The younger specimens are typically striped. In the largest, and perhaps oldest, the stripes are missing and are replaced by numerous blue-white punctations scattered on the dorsal surface.

Ameiva undulata podarga Smith

Ameiva undulata podarga Smith, Univ. Kansas Sci. Bull., vol. 31, pt. 1, 1946, pp. 40-43, figs. 1D, 2A.

Six specimens (nos. 541-546) were obtained in the Xilitla region. The specimens appear to be typical of this form.

Xenosaurus newmanorum sp. nov.

Type: No. 499 Louisiana State University. Collected in the Xilitla region, San Luis Potosí, México.

Paratypes: Nos. 489-498; 500-504, L. S. U., same locality.

Diagnosis: Related to *Xenosaurus grandis* but with the following differences: supraocular scales smaller, never forming a continuous series of three or four, that are much wider than long; tail a little shorter and slenderer with 2-4 scales fewer in a whorl about tail near base; arm above nearly uniformly covered with large rounded scales, somewhat conical on dorsal surface, rather than with the tubercles spaced with the distance between nearly equal to diameter of the base of the tubercle; a pair of light spots beginning between auricular membranes and extending back for a distance less than, or equal to, their width; a broad distinct stripe begins near tympanum that runs up and back, approaching but not meeting its fellow behind posterior level of arm insertion; venter nearly uniform grayish white, instead of cream with numerous quadrangular black spots.

Description of the type: Dorsal outline of the head triangular or arrow shaped, the temporal region slightly curving and bulging out in front of the tympanum, which faces outward and backward; the canthus rostrailis is poorly developed and there is no canthus temporalis; rostral narrower than mental, 1½ times as wide as high, highest at median point, notched laterally above; no distinctly enlarged medial scale touching rostral; circumorbital rings moderately developed, separated by a single series of roughened scales; scales of dorsal surface of head rough, keeled, ridged, or somewhat conical, those in internasal and temporal regions largest and with a few scattered minute granular scales between; in temporal region, scales distinctly conical, separated by irregular rings of minute granular scales; median supraocular scales somewhat enlarged but not forming regular series, often subcircular and moundlike; superciliaries 11-11; 13-13 suboculars; nostril in single nasal; supralabials 13-13; infralabials, 11-12; a series of scales bordering supralabials above heavily ridged posterior to nasal; a row of enlarged scales begin behind eye and run back on temporal region, usually bordered by one row of scales on each side also somewhat enlarged.

Body covered with rounded or oval somewhat conical scales separated by smaller similar scales mixed with minute granules of varying size.

A skinfold on neck, with often another indistinct one preceding it; an average count of about 43 scales in a line between neck fold and tip of chin (counts may vary three or four scales if made at different points); beginning at about level of axilla, a series of transverse scale rows cross the ventral surface, terminating posteriorly at about the level of the groin. These individual scales are quadrangular and there are 18-20 in the widest rows; on sides they merge into the more rounded lateral scales; a lateral skinfold from axilla to groin along sides, running close to ends of ventral series.

On median ventral line 78 scales from base of tail to tip; 107 scales on dorsal part of tail; tail surrounded by whorls of scales, every other whorl breaking up into two rows on the sides so that the dorsal count is usually nearly a third greater than ventral; ventral part of tail compressed and narrowed.

Dorsal surface of arm regularly scaled, the tubercles in contact, with occasional granules in the interstices; on the posterodorsal part of thigh, tubercles are farther apart, not in contact.

Tympanum smooth not covered with granules, higher than wide, its greatest diameter equal or very slightly less than length of eye

orbit; fingers and toes well developed, somewhat angular, claws strong; 32 scales under fourth toe; toes of hind limb reaching half way between elbow and arm insertion when limbs are adpressed to body; maxillary-premaxillary teeth, 23 on each side.

Color: Head with a ground color of brownish gray; numerous dark brown flecks forming indistinct lines running back from eye and a large more or less distinct dark mark in the occipital region; back with five or six broad brown bands with deep black irregular edges and lineated series of black tubercles; eight dark bands round tail, the under parts of bands split with lighter color; the brown bands are separated by bluish gray bands that are diagonal on the sides and are interrupted medially on back by a very narrow streak of brown; these light bands may be edged with black and there may be some scattered black tubercles; chin, throat and venter dirty white or slightly bluish white. (Under a lens there is to be seen a fine, nearly uniform, scattering of pigment.)

The brown neck band is somewhat triangular; the middle one on the back tends to be partially divided by an extra gray band. Arms and legs indefinitely flecked with brown, black, and gray above, nearly uniform gray below; digits indefinitely banded with gray.

Measurements in mm.: Snout to vent, 112; tail, 106; head width, 25; head length to front edge of tympanum, 31; axilla to groin, 51; snout to forearm, 44; body width, 23; arm, 40; leg, 50.

Remarks: The differences between this form and the typical one occurring in Veracruz near Córdoba are numerous but not of great magnitude. Certain of these have been pointed out in the diagnosis; the following differences exist between *Xenosaurus grandis* and *newmanorum*: In *grandis* the head is more distinctly triangular, the canthus temporalis more distinct, and the sides of the temporal region more nearly vertical; the tympanum is entirely covered with a thin scaly membrane (apparently absent in *newmanorum* or if present, lacking scales); the area of small scales behind the vent is larger, arranged in seven or eight rows (usually only four, and the scales back of anal lip larger in *newmanorum*); the preanal scales more uniformly developed. In the basal portion of the tail every fifth whorl is divided, but in the remainder of the tail every other row splits. This takes place lower down on the side, often only the ventral median pair being undivided. The lower labials have a low lateral ridge, less conspicuous than that in *newmanorum*. The enlarged row of ridged scales below the infralabials

MEASUREMENTS AND SCALE DATA OF *XENOSAURUS NEWMANORUM* sp. nov.

No.	Snout to vent	Tail	Head width	Head length to ear	Supra-labials	Infra-labials	Transverse scale rows axilla to groin	Ventral caudals	Dorsal caudals	Scales from neckfold to tip of chin
499	112	106	25	31	13-13	11-11	36	78	107	45
496	110	101	24	30	14-13	10-10	35	79	109	40
492	110	102	26.5	31	14-15	10- 8	35	78	109	43
489	113	110	25	31	14-15	10-13	38	79	110	41
493	108	102	23	30.5	13-12	10-10	35	80	108	41
495	107	102	23	30.5	14-15	11-11	36	79	111	46
500	107	102	26	30	12-12	9-10	36	79	104	43
497	106	100	23	29	14-13	10-10	37	80	112	45
494	105	105	24	29	14-15	10-11	37	79	111	45
501	102	102	23	28	13-14	10-11	35	79	114	39
498	100	96	23	28	13-12	11-11	37	79	109	42
503	100	100	21	27.5	14-15	10-11	36	79	111	44

are wider than in *newmanorum*. The first and second pairs of chinshields are in contact with the infralabials, while those following are separated from the labials by the series of ridged scales. (In *newmanorum* there are eleven specimens in which only first pair touches labials; three in which one of second pair touches; in two, all the scales of the chin are distorted and seemingly abnormal.)

The genus is known from México and Guatemala. *Xenosaurus grandis* occurs in the region about Córdoba, Cuautlapan, Huanusco, Orizaba and Tehuantepec in México; *X. rackhami* is a Guatemalan species.

The specimens of *X. grandis* that I collected at Cuautlapan were ensconced between lamina of rock, where softer layers had been weathered away leaving narrow spaces between harder layers; it is not known whether a similar habitat is occupied by *X. newmanorum*.

The species is named for Mr. Robert Newman and Mrs. Marcella Newman who obtained the specimens.

Barisia imbricatus ciliaris Smith

Gerrhonotus levicollis ciliaris Smith, Proc. U. S. Nat. Mus., vol. 92, 1942, pp. 365-367. (Type locality, Sierra Guadalupe, Coahuila, México.)

Barisia imbricatus ciliaris Tihen, Amer. Mid. Nat., vol. (In press.)

This form, previously known from the "mountains near San Luis Potosí [city]" is represented in the collection by a specimen (no. 341) taken at an elevation of 7,000 feet between Llano de Coneja and Llano de Garzas in the Cerro Coneja region. It is a gravid female containing 11 well-developed embryos, probably about ready for birth since the yolk material seems to be entirely absorbed. One embryo measured 36 mm. from snout to vent, the total length being 98 mm.

The following characters are diagnostic:

Dorsal scale rows 16, the six median being strongly keeled, the adjoining rows lightly keeled; 12 ventral scale rows; a single pair of chinshields in contact medially, the upper largest. The measurements (in mm.) are: total length, 293; snout to vent, 115; vent to tip of tail, 178. The adpressed limbs fail to touch.

The azygos postmental present on the specimen is perhaps abnormal for this form since only in four of the eleven young is it present; and while two loreals are present in this specimen, one is the more usual number.

Gerrhonotus liocephalus loweryi Tihen

Gerrhonotus liocephalus loweryi Tihen, Trans. Kansas Acad. Sci., vol. 51, 1948, pp. 302-305.

This spendid series has recently been studied and named by Dr. Joseph Tihen. The type is LSU no. 480. The paratype series, LSU nos. 472-479, 481-485, 485a, 486-487. All are from the Xititla region. One specimen from Ciudad Maiz, no. 488, has been tentatively referred to this form, but it differs in a number of points. It is possible that these presumed differences are juvenile characters.

Eumeces tetragrammus (Baird)

Plestiodon tetragrammus Baird, Proc. Acad. Nat. Sci. Philadelphia, 1858, p. 256. (Type locality, Lower Rio Grande River.)

Eumeces tertagrammus Cope, Bull. U. S. Nat. Mus., no. 1, 1875, p. 45; Taylor, Univ. Kansas Sci. Bull., vol. 23, 1935 (Aug. 15, 1936), pp. 298-304, fig. 46.

An example of this species no. 343 collected at Ebano appears to be typical in coloration, and the scale data fall within the known limits of variation.

TESTUDINATA

Terrapene mexicana (Gray)

Cistudo (*Onychotria*) *mexicana* Gray, Proc. Zool. Soc. London, 1848 (Feb., 1849), pp. 16-17, pl. 2. (Type locality, México.)

Terrapene goldmani Stejneger, Proc. Biol. Soc. Washington, vol. 46, 1943, pp. 119-120.

Terrapene mexicana Müller, Zool. Anz., Bd. 113, Heft 5/6, 1936, pp. 97-114, figs. 1-4.

Three specimens of *Terrapene* are in the collections; no. 332 Valles, S. L. P.; nos. 333 and 334 being from Ebano, S. L. P.; while no. 335 was taken at Pujal, S. L. P.

Despite rather extraordinary differences in the general appearance, all three are referred to *Terrapene mexicana* (Gray), a species described nearly a hundred years ago from a specimen of unknown provenance in México. The type specimen has a dark brown carapace, the dorsal and lateral plates being spotted and rayed with cream. The scales on the arms are dark, and most of those on the anterior face of the arm bear a yellow or orange spot. Four claws are present on the fore foot. There are three claws on the hind foot.

Stejneger has described a *Terrapene goldmani* from "Chijol (or Chijoles), southeastern corner of the State of San Luis Potosí, México; in the coastal plain." This species also has only three claws on the hind foot. The carapace is nearly uniform "clay-color" with well-defined broad dark-brown margins to each plate along the seams. The color of the arms and legs is not mentioned.

Müller (*loc. cit.*) has reviewed a series of *Terrapene* collected for

the most part in the region about Tampico, Veracruz. He has concluded that *Terrapene goldmani* and *Terrapene mexicana* are synonyms. Whether he is correct in his interpretations cannot be decided on the basis of these specimens. The more outstanding characteristics of each of these is given.

No. 332 (collected by Chas. Shaw, Valles, San Luis Potosí, Oct. 11, 1946). This specimen has a high, laterally compressed carapace, with a continuous, flat crest on the second, third and fourth vertebral scales. The keel can be distinguished also on the first vertebral. A small nuchal is present. The marginal scales flare out posteriorly and are strongly serrate. The foot has three claws. The upper parts of the sides slope sharply, giving the carapace a tectiform shape.

The general color is yellowish olive, the sutures of all the plates being dark, black brown. The plastral plates are similarly colored, in that the posterior edges of the scutes and the median sutures are dark brown. The chin and lips are dull brownish-white without any markings. An indefinite grayish spot is present on each side of the mandible. The neck, arms, legs and feet are uniform olive-brown without trace of yellow spotting on scales. The top of the head is brown with some marbling of dirty cream. The tip of the snout and maxilla are light olive. The area about the nostrils is yellowish tan.

No. 333 from Ebano is the largest specimen. The carapace slopes regularly on the sides. The sutures are bordered by wide areas of dark black-brown. The scales on the front of the arms have yellow spots, or are yellow with darker edges. The top of the head and to a lesser extent the neck above, and side of head is covered with numerous black spots. A pair of vertical lines is present on the front of the beak which is very slightly notched. The plastron has a broad dark area bordering the sutures, but some yellowish areas are present near the outer border. The chin is whitish.

No. 334, from the same locality, lacks the dark stripes along the sutures but does show what appear to be remnant spots and rays of dark brown on a lighter olive ground color. The larger scales on the arms are blackish with yellow centers. The top of the head is more or less uniform bluish gray.

The specimen from Pujal (no. 335) has the dark stripes along the sutures rather indistinct and some indistinct darker markings suggesting spots or rays. There is a very small amount of dark brown on the carapace, scattered in irregular areas along the sutures. The throat is strongly reticulated with black.

A very slight longitudinal convexity is discernible crossing the upper half of the costals. The arms are spotted with yellow.

Measurements of Terrapene mexicana (Gray)

	no. 333	no. 334	no. 335	no. 332
Length of carapace	166	150	153	132
Length of plastron	164	138	142	126
Width of carapace	128	119	121	113
Width of plastron	94	85	87	81
Greatest height of carapace and plastron	88	72	78	82

SERPENTES

Leptotyphlops myopicus myopicus (Garman)

Stenostoma myopicum Garman, Mem. Mus. Comp. Zool., vol. 8, 1883, pp. 6, 130, 131. (Type locality Savineto, near Tampico, Tamaulipas.)

Leptotyphlops myopicus myopicus Smith, Field Mus. Nat. Hist. Publ., Zool. ser., vol. 29, 1944, p. 146.

An individual of this very rare species (no. 201) taken November 13, 1946, by Marcella Newman at Ebano, yields the following data:

Total length, 214 mm.; tail, 10.5 mm., head width, 3.5 mm., body width, 3.5 mm. Dorsal scales (transverse scale rows) total 120; on tail 14, the first pair following anus divided; others single. Anal a large undivided scale; 14 scales in a row about body. Width of rostral slightly more than one-third greatest width of head, extending back to level of eyes or slightly beyond; nasal completely divided, the suture passing from nostril reaches first labial, the upper part of scale much larger than lower, and separated from its fellow of the opposite side by a small prefrontal; supraocular small, much above level of eye; frontal about size of prefrontal; parietals wide, the anterior reaching the last (third) labial, each separated from its fellow of the opposite side; labial border formed by rostral, nasal, two anterior labials, the ocular, and third labial; rostral occupying greatest space, the third labial a slightly shorter space on the labial border.

The lower lip of this specimen is strongly notched mesially, with four infralabials on each side of the diminutive mental. The fourth labial is concealed entirely below the supralabials.

Constrictor constrictor imperator (Daudin)

Boa imperator Daudin, Histoire naturelle . . . Reptiles, vol. 5, 1803, pp. 150-152. (Type locality, México.)

Constrictor constrictor imperator Ihering, Rev. Mus. Paulista., vol. 8, 1910, p. 321.

Two specimens, nos. 202-203, are in the collection. The data on these two specimens are, respectively: Ebano, Xilitla; female, fe-

male; scale formula, 54-64-38; 56-66-36; ventrals, 230, 236; subcaudals, 53, 41+; supralabials, 21-19, 19-20; infralabials, 22-?, 23-22; total length, 1700, 1830; tail length, 160, 162+.

Adelphicos quadrivirgatus quadrivirgatus Jan

Adelphicos quadrivirgatus Jan, Arch. Zool., vol. 2, 1862, pp. 18-19, pl. 8; Elenco sist. ofidi, 1863, p. 32; Jan and Sordelli, Iconographie Générale des Ofidiens, livr. 11, 1865, pl. 3, fig. 5. (Type locality, México.)

Adelphicos quadrivirgatus quadrivirgatus Smith, Proc. Rochester Acad. Sci., 1942, pp. 188-192, figs. 3 and 6.

Smith, *loc. cit.*, notes that seven specimens of this species are known, four of them having been taken in Mexico, three in Chiapas. The known range extends from central Chiapas to Jicaltepec, central Veracruz. Two mutilated specimens in the collection, no. 205 from Ebano, and 206 from Xilitla, trace the range from Jicaltepec about 90 miles farther to the northwest. The latter half of the body of the Ebano specimen is missing; consequently the scale counts of this part are unknown, and the sex cannot be determined.

The general color is brownish-faun, most of the scales having more pigment on the edges than in the center. A nearly continuous black lateral line runs between the second and third scale rows, reaching to near the tip of the tail. A dorsolateral line begins near the parietal, and follows a course through the middle of the fifth scale row. The median dorsal scale row is pigmented slightly more than adjoining rows, but would not be described as bearing a stripe. The labials are cream, save for their brownish upper edges. The venter is white save for a fine zigzag line under tail. The top of the head is gray, the scales flecked with black.

The scale formula for no. 206 ♀ is 15-15-13; ventrals, 148; supralabials, 7-7; infralabials, 5 (the anterior chinshield bordering the mouth also); no preoculars, postoculars, 2; temporals 1+1; one loreal entering eye; anal divided. Tip of tail absent.

The mutilated specimen (no. 205) disagrees in no character that can be discerned.

Ficimia streckeri Taylor

Ficimia streckeri Taylor, Copeia, 1931, p. 5-7. (Type locality, 3 miles east of Rio Grande City, Texas); Mulaik and Mulaik, American Mid. Nat., vol. 29, no. 1, May, 1943, pp. 796-797.

Ficimia olivacea streckeri Smith, Publ. Field Mus. Nat. Hist., Zool. Ser., vol. 29, 1944, p. 139; Smith and Taylor, Bull. U. S. Nat. Mus., no. 187, 1945, p. 63.

A series of 10 specimens of this burrowing species was acquired in the Xilitla region. It is important since it gives a better idea of the range of variation in the form.

The preoculars are uniformly 1-1; the supralabials 7-7 save in no. 221, which has the first three fused into a single scale; infralabials, 7-7, save in one specimen with 7-8 on one side. There is no loreal.

Data on Ficimia streckeri Taylor

No.	Sex	Post-ocular	Scale formula	Ventrals	Caudals	Total length	Tail length
207	♂	1-1	19-17-17	146	34	139	22
208	♂	2-2	19-17-17	144	36	418	69
209	♂	2-2	17-17-17	148	36	424	66
210	♂	2-2	17-17- ?	154	37	443	68
211	♂	2-2	19-17-17	150	36	251	38.5
212	♂	1-1	18-17-17	147	38	470	75
213	♂	2-2	19-17-17	150	36	483	74
214	♂	2-2	19-17-17	144	36	372	59.5
215	♀	1-1	17-17-16	155	32	390	55
216	♀	2-2	19-17-17	154	30	250	31.5
217	♀	1-1	19-17-17	157	34	450	60

These specimens differ in some characters from those in the type area in south Texas. Muliak and Muliak, *loc. cit.*, give data on a series of specimens (over 30?). A comparison of their ventral counts and subcaudal counts with the Xilitla series is given. Numbers in parentheses are averages.

Texas	♂ ♂	128-144	....	35-40	....
Xilitla	♂ ♂	144-154	(148)	34-38	(36)
Texas	♀ ♀	144-150	....	30-34	....
Xilitla	♀ ♀	154-157	(153.3)	30-34	(32)

In Texas specimens the supralabial number is 7; infralabials, 8 most frequently, with 7-7, or 7-8 less often; preoculars, 1; postoculars, 1 (one exception); temporal formula, 1+2.

The Xilitla specimens have, normally, supralabials 7; infralabials, 7 (one exception, on one side); preoculars, 1; postoculars, 2-2 in 7 and 1-1 in 4 cases; the usual temporal formula is 1+2.

Smith, *loc. cit.*, has recently associated this form with *Ficimia olivacea* as a subspecies on the basis of presumed intergrades between the two species. He is followed in this by Smith and Taylor, *loc. cit.* However, this lot of material seems to show no evidence of intergradation, and even with the loss of much of the dorsal color pattern as occasionally occurs, there is no approach to the more narrow, flatter-headed species with a differently colored, more slender body.

Schmidtophis genus novum

Maxillary teeth eight or nine, decreasing in size posteriorly. Head moderately elongate, scarcely distinct from neck. Eye small with an elliptic pupil. Scales without striations, but with dim keels in 15 rows; large paired marginal "pits" on many if not all scales of

anterior part of body; scale row formula, 15-15-15; ventrals rounded; anal single; tail short with subcaudals in two rows; prefrontals fused entering eye; loreal entering eye, no preoculars; supraocular and postocular present, not fused; no anterior temporals. Nasal at least partially divided.

The relationship of the genus is with *Geophis* and *Chersodromus*.

The genus is named for Karl Patterson Schmidt.

Schmidtophis rubriventris sp. nov.

Type: Louisiana State University No. R. 577. Collected near Xilitla (Xilitla Region) San Luis Potosí, México, by Charles Shaw.

Diagnosis: Characters of the genus. A very broad rostral one third broader than high, one subtriangular supraocular; one postocular much higher than long; frontal as long as its distance from internasals; body scales lightly keeled, save entire outer row, and part of second row; no primary temporal. Body black, venter pink, a white band across middle of parietals joining the white of throat. Scales in 15 rows; 6-6 supralabials. Ventrals, 125, caudals, 41.

Description of type: Rostral broader than long, the part visible above broad and narrow, its posterior border forming a very oblique angle; internasals small, about one and one-half times as wide as long; prefrontals fused together, the anterior border of scale somewhat convex, the posterior border somewhat concave; frontal rather small, subtriangular, the anterior border slightly curved, its width greater than its length, its length equal to its distance from internasals; supraoculars rather large, subtriangular; length of parietals equal to their distance from internasals; nasal large, at least partially divided, the length of its rostral border greater than its distance from eye, the anterior part greater in area than posterior part; loreal large, nearly rectangular (the lower edge slightly angular), a little longer than high, entering eye; postocular at least twice as high as long; fifth labial broadly in contact with parietal; no primary temporal, one secondary temporal shaped like a body scale; six supralabials, in the following ascending order of size: 1, 2, 3, 4, 6, 5; the third and fourth supralabials enter eye; seven infralabials, in following ascending order of size: 2, 1, 3, 4, 6, 7, 5, the first pair in contact behind the small mental; first pair of chinshields relatively large, bordered by five infralabials; second pair of chinshields less than half size of first pair, in contact with each other. The scales are smooth and lack any trace of striation; and the keel is weak, but somewhat more pronounced posteriorly; outer row and

part of second not keeled. Scale formula, 15-15-15; ventrals, 125; anal undivided; subcaudals, 41+1.

Color: Color deep slate-black on dorsum and sides; a white band with irregular borders crosses the back part of head on parietals passing down on throat where it widens, covering about four ventrals and the posterior chinshields; head and supralabials black; infralabials grayish black with a light area on mental and light areas on last three infralabials; first pair of chinshields whitish with grayish black anterior borders; ventrals and subcaudals uniform pink, the outer edge of ventrals colored like lateral scales.

Teeth: The short maxillary bears six teeth, with places for two or three more. Anterior teeth larger, very slender, curved, growing smaller posteriorly.

Measurements in mm.: Total length, 308; tail, 68; width of head, 6.3; length of head, 8; diameter of eye, 1.2.

Remarks: This novelty seems to mimic *Chersodromus leibmannii* (Reinhardt), which may occur in the same locality but the nearest point at which the latter has actually been found is in central Veracruz about 180 miles to the southeast.

The chief generic characters by which it differs from *Chersodromus* are: smooth instead of finely striated scales; absence of an anterior temporal allowing the fifth supralabial to form a long contact with the parietal; the smaller series of maxillary teeth, decreasing in size posteriorly; and the reduction of the scale rows from 17 to 15; the supraocular and postoculars separate rather than fused.

There is some similarity to certain members of the genus *Geophis*, especially those lacking anterior temporals. However the fusion of the prefrontals in this species would prevent confusion with these forms.

Geophis multitorques (Cope)

Rhabdosoma multitorques Cope, Proc. Amer. Philos. Soc., vol. 22, 1885, pp. 384-385. (Type locality, Zacualtipan, Hidalgo.)

Geophis multitorques Günther, Biologia Centrali-Americana, Reptiles, 1893, p. 93; Smith, Proc. New England Zoöl. Club, vol. 18, 1941, pp. 53-55.

Two specimens, nos. 218 (young) and 219 (adult female), from the Xilitla region, are referred to this species. The scale data of the two specimens agree for the most part.

The scale formula is 17-17-17; supralabials, 6; infralabials, 7; no preocular; postocular, 1; temporals, 1+2; second pair of chinshields in contact. The ventrals of no. 218 are 174, of no. 219, 177; caudals are 30 in both. The measurements (in mm.) are, respectively: total length, 171, tail, 21; 443, tail, 51.5.

Above, the color is brownish black to black, the skin between the scales being lighter. A parietal collar is present in no. 218 covering about half the length of the parietals. It crosses the sides of the mouth and widens to encompass the greater part of the underside of the head. In both, the ventral surface of the body is black or blackish brown with numerous white areas. These are sometimes arranged as alternate spots, often contiguous or narrowly separated, sometimes confluent. The undersurface of the tail is nearly uniform black.

Ninia diademata plorator Smith

Ninia diademata plorator Smith, Copeia, 1942, no. 3, Oct. 8, pp. 152-154. (Type locality, Durango, Hidalgo, México.)

In defining this subspecies, Smith, *loc. cit.*, had data from but two specimens. The present series of six from the Xilitla region of San Luis Potosí contribute to a better understanding of the variation in the form.

The color of all the specimens agrees with that given for the type. The scale formula, 19-19-19, is invariable (stated in error by Smith, "18 scale rows" in the diagnosis, but given correctly in the description). The supralabials are 6-6 in five, 6-5 in one, specimen. Thus the count of five supralabials in the type is apparently not the normal condition for the subspecies. Six infralabials are present. The temporals are constantly 1 + 2, no preocular, 2 postoculars, the upper the larger. Four labials touch the anterior chinshields. In these characters, agreement with the type is complete. There are invariably two pairs of chinshields, the anterior much the larger.

Data on Ninia diademata plorator Smith

No.	*Sex*	*Locality*	*Ventral*	*Caudal*	*Total length*	*Tail length*
220	♂	Xilitla region	133	83	254	82
221	♀	Xilitla region	130	81	315	100
222	♀	Xilitla region	129	74	290	88
223	♀	Xilitla region	137	73	312	89
224	♂	Xilitla region	125	88	302	98
225	♂	Xilitla region	128	93	225	78

The variation in the ventral and caudal scale counts (including data on the types) is as follows: 123-133, 83-93 for males; 129-137, 73-81 for females.

The counts in the form *Ninia diademata diademata* are distinctly higher (136-145; 86-97 for males; 136-159; 79-96 in females). The averages for these data are:

N. d. plorator .....126.8—87.6 for males; 132—72 for females.
N. d. diademata .....141.8—91.4 for males; 149.5—86.3 for females.

The stomachs of three of the specimens contained remains of small slugs. One specimen contained oviductal eggs.

This is the first record of the species for the state.

Rhadinaea crassa Smith

Rhadinaea crassa Smith, Proc. Biol. Soc., Washington, vol. 55, 1942, pp. 190-191, fig. 3, 4. (Type locality Durango, Hidalgo, México.)

This recently described species has been known previously from five specimens, one of which, a paratype, is from Ciudad Maiz, in San Luis Potosí. Three more specimens, nos. 262, 263, and 264, have been collected by Mrs. Marcella Newman in the Xilitla region. All are males and appear to have a larger series of ventrals than the more typical, described specimens.

The following characters are invariable in the three: supralabials, 8-8; infralabials, 9-9; preocular, 1; postoculars, 2; temporals, 1+2; loreal, 1; anal, 2; five scales touch the anterior chinshields; scale formula, 17-17-17.

Data on Rhadinaea crassa Smith

No.	*Sex*	*Locality*	*Ventrals*	*Caudals*	*Total length*	*Tail length*
262	♂	Xilitla	185	91	587	176
263	♂	Xilitla	181	94	545	162
264	♂	Xilitla	184	92	587	176

The color patterns of these three specimens agree with each other, and likewise with that of the type specimen.

Females of a snake species usually have a higher average number of ventral scales than the male. In the three typical specimens of *R. crassa* from which data on ventral counts are available, all are females, and the range of the ventral counts is 166-173, average 170.6. It is presumed that typical males would have a lower average.

In these Xilitla specimens the range for three males is 181-185 with an average of 183.3, a difference of at least 13 ventral scales greater than the females of the species. It may also be larger than the average for typical males.

Rhadinaea decorata (Günther)

Coronella decorata Günther, Catalogue of the snakes of the British Museum, 1858, pp. 35-36. (Type locality México.)

Rhadinaea decorata Cope, Proc. Acad. Nat. Sci. Philadelphia, vol. 15, 1863, p. 101.

This species, not previously known from the state, is represented by three male specimens (nos. 265-267), all from the Xilitla region. They extend the known range approximately 100 miles to the northwest. To the south the species reaches to Costa Rica.

These specimens agree with the more southern specimens in having the scale formula, 17-17-17; supralabials, 8-8, infralabials, 10-10, five touching the first chinshields; preoculars, 1-1, postoculars, 2-2, temporals, 1+2.

Only one specimen, no. 266, has the tail complete. The ventral counts for the specimens nos. 265, 266, and 267 are, 126, 118, 121, respectively. The caudals for no. 266 are 121. The ventral coloration of the preserved specimens is creamy white. The color in life was not recorded.

The stomachs of two specimens contained the partially digested remains of earthworms.

Rhadinaea marcellae sp. nov.

Holotype: Louisiana State University no. 270, from Xilitla region, San Luis Potosí, México, May 12, 1947. Collected by Marcella Newman.

Diagnosis: Dorsolateral light line on head beginning on the snout, running through upper edge of eye to behind mouth angle, then back and upward to join the lateral body stripe, which occupies the fifth rows and is composed of a series of disconnected light spots each covering about half of a scale; a nuchal white black-edged collar connecting the ends of the lateral body stripes; head with a somewhat elaborate stippled pattern; outer edge of ventrals dark, the area intensified at the posterior outer edges of the scales. Black dots on most of the supralabials, and smaller spots on mental and three first infralabials; 2 preoculars, the lower small; ventrals, 128; caudals, 78; four infralabials touch first chinshields.

Description of the type: Rostral wider than high, visible only as a narrow line when seen from above; internasals more than half of the length of the prefrontals; frontal one third longer than wide, about one third longer than its distance from the tip of the snout; parietals a little longer than their distance to the tip of the snout; nasal divided; loreal quadrangular; two preoculars, the lower very small, separating the third labial from the orbit; two postoculars, the upper more than three times area of lower; anterior temporal large, followed by two smaller temporals; 8-8 supralabials, the sixth and seventh very large and subequal in area, the fourth and fifth form the lower border of the orbit; eye very large, greater than its distance to the anterior edge of the nostril; 8-9 infralabials; two pairs of chinshields, the anterior broader, but somewhat shorter than the posterior; 4 labials touching anterior chinshields. Scale formula, 17-17-17. Ventrals, 128; caudals, 78; anal divided.

Total length, 290 mm., tail, 93.

Color and markings: A line from tip of snout through upper part of the eye, then diagonally to behind mouth angle, then back and

up joining the lateral body line; a black-edged white nuchal collar joining the ends of the dorsolateral lines which are very narrow (about the width of half a scale), formed of a series of small separate whitish spots each about half the area of one scale, and following the fifth scale row. Below this a very narrow dark line, less than half a scale in width, and covering part of lower edge of the fifth and the upper edge of the fourth scale row. All scales on body have the borders darkened somewhat, those of the median dorsal row visibly darker than others, making a dim median stripe; scales of the nine median rows discernibly lighter than the lateral scales; edges of the ventrals with pigment, intensified more or less into an elongate spot on outer edge. Top of head with an elaborate scroll-like pattern; a pair of fine light spots on parietals and two lighter-centered dark spots on each prefrontal; the dark band in front of eyes is continuous across the end of the snout; upper edges of supralabials with a series of black spots on the white supralabial band; entire ventral surface immaculate.

Remarks: The nuchal collar, the head pattern, the presence of two preoculars and the greatly reduced ventral series seem to separate this form from other known species of *Rhadinaea.*

Rhadinaea lachrymans has a nuchal collar but lacks the line from the eye connecting with the lateral line, but it has fewer labials (7), one instead of two preoculars, a higher series of ventrals (159-164) (caudals 84-95) and a completely different body pattern.

While it differs strikingly from the head and body pattern of *Rhadinaea decorata,* the reduced ventral count (128) falls into the known range of that form (113-130; 86-123 caudals).

The species apparently belongs in the group to which *R. crassa, R. forbesi, R. gaigeae, R. quinquelineata* and *R. montana* belong, and its closest relationship is probably with *crassa.* This species however lacks a nuchal collar and has a higher ventral count. The general color pattern is similar but the details of the pattern differ.

Thalerophis mexicanus mexicanus Duméril, Bibron, and Duméril

Leptophis mexicanus Duméril, Bibron and Duméril, Erpétologie Générale, vol. 7, pt. 1, 1854, pp. 536-537. (Type locality, México.)

Leptophis mexicanus mexicanus Oliver, Occ. Papers Mus. Zool. Univ. Michigan, no. 562, 1942, p. 10.

A series of seven specimens were obtained in the Xilitla region.

The scale formula is 15-15-11; preoculars, 1; postoculars, 2; loreal, 1; anal, 2; 5 labials touching first chinshields. These characters are invariable.

Data on Thalerophis mexicanus mexicanus Duméril, Bibron and Duméril

No.	*Locality*	*Sex*	*Ventrals*	*Caudals*	*Supra-labials*	*Infra-labials*	*Total length (mm.)*	*Tail length (mm.)*
251	Tamuin	♀	173	164	8-8	10-10	337	123
252	Xilitla	♀	175	163	8-8	10-10	984	373
253	Xilitla	♂	163	167	8-8	10-10	1231	496
254	Xilitla	♂	164	154	8-8	11-11	1122	...
255	Xilitla	♀	176	164	9-8	10-10	1277	490
256	Xilitla	♂	168	160	8-8	11-11	...	...
257	Xilitla	yg.	163	164	8-8	10-10	227	141

Dryadophis melanolomus veraecrucis (Stuart)

Eudryas boddaerti mexicanus Stuart, Occ. Papers Mus. Zool. Univ. Michigan, no. 254 1933, pp. 8-9. (Type locality, Zacualpan, Veracruz, México.)

Dryadophis melanolomus veraecrucis Stuart, Misc. Publ. Mus. Zool. Univ. Michigan, no. 49, 1941, pp. 91-93, pl. 4, fig. 6, map 4 (substitute name for *mexicanus*).

Sixteen specimens, all from the Xilitla region, are in the collection. The young specimens have a white line from the tip of the snout along the lip that continues as a narrow line on the neck for a distance equal to 16 transverse scale rows. This line is interrupted beneath the eye by a black inverted "V." A series of white marks are present on the lower lip, and also on many of the chin scales, continuing on to the first part of the ventral series where they are larger and arranged in two rows.

Except for the labial line, some trace of this juvenile pattern can be discerned in certain adult specimens.

The scale formula is invariable 17-17-15 in the series. There is no variation in the following characters: preocular, 1; postoculars, 2; loreal, 1; anal, 2. The temporal scales, however, are variable. The formula $\frac{2}{1} + 2$ is most frequent, but $2 + 2$ occurs nearly as frequently and $2 + 2 + 2$ is found in four cases. Five scales are invariably in contact with the chinshields.

Data on Dryadophis melanolomus veraecrucis (Stuart)

No.	*Sex*	*Ventrals*	*Caudals*	*Supra-labials*	*Infra-labials*	*Total length*	*Tail length*
232	♂	178	...	9-9	10-10	....	...
233	♂	174	94+	9-9	11-10	1234	396+
247	♂	169	105	9-9	11-11	1061	324
234	yg.	180	71+	9-9	11-10	435	120
235	♂	176	111	9-9	11-10	1038	318
236	♂	177	103	9-9	11-11	939	284
237	♂	171	104	9-9	10-10	1100	333
238	♂	178	105	9-9	11-11	1131	330
239	♂	177	96+	9-9	10-11	1066	314+
240	yg.	174	104	9-9	10-10	611	180
241	♂	173	110	9-9	11-10	1086	315
242	♂	177	93+	9-9	11-10	1095	314+
243	♂	172	98	9-9	10-10	1173	342
244	♂	176	105	9-10	11-11	1209	368
245	♂	181	...	9-9	10-10	....	...
246	♀	179	102	9-9	11-11	1095	325

Drymarchon corais erebennus (Cope)

Spilotes erebennus Cope, Proc. Acad. Nat. Sci. Philadelphia, vol. 12, 1860, p. 342. (Type locality, Eagle Pass, Texas.)

Drymarchon corais erebennus Smith, Journ. Washington Acad. Sci., vol. 31, 1941, pp. 478-479, map, fig. 2.

Three specimens (nos. 248-250) were collected in the Xilitla region. The following characters are invariable in the specimens: preocular, 1; postoculars, 2, temporals, 2 + 2; supralabials, 8; infralabials, 8.

Data on Drymarchon corais erebennus (Cope)

No.	*Sex*	*Ventrals*	*Caudals*	*Scale formula*	*Total length*	*Tail length*
248	♀	182	65	19-17-14	1510	270
250	♂	187	65	18-17-14	1544	298
249	♀	191	65	17-17-14	1804	281

Spilotes pullatus mexicanus (Laurenti)

Cerastes mexicanus Laurenti, Specimen medicum exhibens synopsin reptilium, 1768, p. 83. (Type locality, México.)

Spilotes pullatus mexicanus Amaral, Mem. Inst. Butantan, vol. 4, 1929, pp. 282-284, fig. 2.

Two large specimens from the Xilitla region give the following scale data:

Data on Spilotes pullatus mexicanus (Laurenti)

No.	*Sex*	*Ventrals*	*Caudals*	*Supra-labials*	*Infra-labials*	*Total length*	*Tail length*
260	♂	202	124	8-8	9-8	2080	565
261	♂	205	121	8-8	9-8	1990	530

The preoculars and postoculars are 1 and 2, respectively, and the scale formula is 16-18-12 in both. The coloration is normal for the subspecies. There is a tendency for the posterior labials to fuse with the temporals.

Pituophis deppei jani (Duméril)

Elaphis deppei Duméril, Mem. Acad. Inst. France, vol. 23, 1853, p. 453. (Type locality México.)

Pituophis deppei deppei Stull, Occ. Pap. Mus. Zool. Univ. Michigan, No. 250, 1932, pp. 1-2.

A single specimen (no. 258) taken in the region near Ciudad Maiz by Mr. Charles R. Shaw, is the first record of this subspecies for the state. While the specimen is anomalous in certain respects, I believe it is correctly referred to this form.

In coloration and markings it agrees reasonably well with specimens from Tamaulipas listed by Stull, *loc. cit.* The top and sides of the head are nearly uniform faun, with the labial region largely cream, but with the pigment intensified on part of the supralabial and infralabial sutures. The light spots are for the most part "en-

closed" by the dark blotches, especially in the middle and posterior parts of the body.

The prefrontal scales, however, are four instead of two, with a small azygos scale just behind the internasal suture. There are eight supralabials; 11-12 infralabials. The scale formula is 29-27-21. Ventrals, 235; caudals 62; anal single; 31 body blotches, black anteriorly, lavender posteriorly; 9 blotches on tail, darker than those preceding.

Drymobius margaritiferus margaritiferus (Schlegel)

Herpetodryas margaritiferus Schlegel, Essai sur la Physionomie des Serpens, vol. 2, 1837, p. 184. (Type locality unknown [stated New Orleans, in error].)

Drymobius margaritiferus margaritiferus Smith, Proc. U. S. Nat. Mus., vol. 92, 1942, p. 383.

The scale formula of all of these specimens is 17-17-15; five labials touch the first chinshields. The temporal formula is 2 + 2 or 2 + 1 + 2. One specimen has 3 postoculars instead of the normal number of 2 on one side. This extra scale apparently is segmented from the sixth labial.

Data on Drymobius margaritiferus margaritiferus (Schlegel)

No.	*Locality*	*Sex*	*Ventrals*	*Caudals*	*Supra-labials*	*Infra-labials*	*Total length*	*Tail length*
226	5.4 mi. W. Ebano	yg.	154	120	9-8	11-11	317	105
227	Xilitla	♂	148	115	9-9	10-10	729	263
228	Xilitla	♂	154	...	9-9	11-11	...	...
229	Xilitla	♂	153	122	9-8	9- 8	900	326
230	Xilitla	♂	153	113+	9-9	10-10	726	239*
231	Xilitla	♀	150	109	9-9	11-11	1157	390

* Extreme tip missing.

Lampropeltis triangulum arcifera (Werner)

Coronella micropholis arcifera Werner, Zool. Anz., vol. 26, 1903, p. 250. (Type locality, México.)

Lampropeltis triangulum arcifera Smith, Proc. Rochester Acad. Sci., vol. 8, Sept. 10, 1942, pp. 175-207.

A series of 5 specimens obtained from the Xilitla region are referred to *Lampropeltis triangulum arcifera* (no. 278) or are presumed intergrades between this species and *L. t. polyzona* (nos. 279-282).

No. 278. This specimen may be regarded as *Lampropeltis triangulum arcifera*. In this the black bands are as wide or wider than the red bands save in the first. Fifteen of the red bands are interrupted by black on the medial line. All red bands save first on tail are interrupted or suppressed completely. The nuchal red band is much reduced, its width being equivalent to five scale lengths.

No. 279 has a number of the dark bands reaching a width equal to that of the red bands and toward the posterior part of the body one or two of the black bands are separated by less than the length of one red scale. The tail has six white bands, and three of the black tail bands are split with red.

No. 280 is similar to this, but more of the red bands are wider than the black ones; three of the black bands are split with red.

No. 281 is similar to the preceding but there are eight white bands on the tail, and only one is partially split with red. The black and red bands are more nearly equal in width. Anteriorly, however, the red bands are wider.

In no. 282, many of the black bands meet (thus dividing the red band) or they are narrowly separated. There are five white bands on the tail, and the red is suppressed except on two of the black bands.

The exact localities for these snakes is not available, the labels bearing the notation Xilitla region. It is not known whether the *t. polyzona* and *t. arcifera* were taken in the same exact locality or whether they were separated by some considerable difference in altitude.

Data on Lampropeltis t. arcifera and intergrades

No.	*Sex*	*Scale formula*	*Ventrals*	*Caudals*	*White body bands*	*Tail bands*	*Temporals*	*Total length*	*Tail length*
281	♂	21-21-19	213	58	22	8	2 + 3	976	125
282	♂	21-21-17	213	51	22	5	2 + 3	1010	152
279	♂	22-21-17	215	49+	23	5	2 + 2	1176	155+
280	♀	22-21-19	208	60	18	5	2 + 2 (2 + 1)	682	115
278	♀	22-21-19	208	55+	25	8	2 + 3 (2 + 3)	540	85+

Lampropeltis triangulum polyzona Cope

Lampropeltis polyzona Cope; Proc. Acad. Nat. Sci. Philadelphia, vol. 12, 1860, p. 258. (Type locality, Cuatupe, near Jalapa, Veracruz.)

Lampropeltis triangulum polyzona Dunn, Occ. Pap. Mus. Zool. Univ. Michigan, no. 353, 1937, p. 1.

Four specimens from the Xilitla region are referred to this subspecies (nos. 274-277). They are in general agreement as to the color pattern. This consists of black-white-black bands, separated by red bands. In each case the red bands are wider, usually much wider, than the bordering bands. The black bands are somewhat wider medially than on the sides or ventrally. All of the specimens have the scale formula 21-21-17.

The anterior red bands are eight to ten scale lengths wide; the light bands usually one and one-half to one scale length wide. All the scales of the red bands are black-tipped and the same is true of the scales of the white bands. On the venter the white bands oc-

cupy one or two ventrals; when only one ventral is covered, some parts of the adjoining ventrals may be white.

The specimens have from 18 to 20 white bands on the body, and four to six white bands on the tail (possibly all with six, since the tail tips are missing in three). Three of the black tail bands are "split with red" of varying width. The ventrals may show darker edges or there may be flecks of black on both red and white scales.

One might expect the range of *Lampropeltis triangulum annulata* to extend south from Tamaulipas and Nuevo León into the northern and eastern part of San Luis Potosí, but as yet none has been found referable to this subspecies.

Data on Lampropeltis t. polyzona (Cope)

No.	*Sex*	*Ventrals*	*Caudals*	*White body bands*	*White tail bands*	*Temporals*	*Total length*	*Tail length*
274	♂	220	52+	18	5	2 + 2 + 3	845	112+
275	♂	213	47+	20	4	2 + 1 + 3	746	132+
276	♂	212	50+	20	4	2 + 3	975	138+
277	♂	214	63	19	6	2 + 3	927	158

Elaphe flavirufa (Cope)

Coluber flavirufus Cope, Proc. Acad. Nat. Sci. Philadelphia, vol. 18, 1866 (1867), p. 319. (Type locality Yucatán.)

Elaphe flavirufa flavirufa Smith, Copeia, 1941, no. 3, p. 132, fig. 2.

Two specimens, no. 271 ♂ and no. 272 ♀, obtained in the Xilitla region, are the first state records.

Scale data for the two, respectively, are as follows: scale formula, 26-29-21, 27-31-23; ventrals, 254, 253; caudals, 108, 105; supralabials, 9-9, 10-9; infralabials, 12-12, 13-14; preoculars, 1-1, 1-1, postoculars, 2-2, 2-2; temporals (somewhat irregular), 3 + 4, 2 + 3; spots on body, 36, 37; spots on tail, 18, 17; total length (in mm.), 632, 1242; tail, 134, 265.

Elaphe laeta laeta (Baird and Girard)

Scotophis laetus Baird and Girard, Catalogue of North American Reptiles, 1853, pp. 77-78. (Type locality, Red River, Arkansas.)

Elaphe laeta laeta Woodbury and Woodbury, Proc. Biol. Soc. Washington, vol. 55, 1942, pp. 139-140.

This specimen (no. 273), the first recorded for the state, was taken at Ebano in the extreme northeastern part. It is a female having 230 ventrals and 70 caudals. The scale formula is 25-27-19; the supralabials and infralabials are 8 and 10 respectively. There are 41 body blotches and 17 blotches on the tail, the most posterior ones being too indistinct to be counted. One preocular and 2 postoculars are present. The total length is 437 mm.; the tail, 71 mm.

Pliocercus laticollaris Smith

Pliocercus elapoides laticollaris Smith, Proc. Biol. Soc. Washington, vol. 54, 1941, pp. 122-123, and vol. 55, 1942, p. 160.

The finding of a specimen of this rare snake at Xilitla by Charles R. Shaw traces its distribution to the northwest nearly three hundred miles, and adds an interesting species to the fauna of the state.

There is a white band, bearing a fine peppering of pigment, that crosses the back of the head involving all of the parietals save their anterior edges, and including the anterior part of the first scale row following the parietals. The band is continuous with the white color which covers the chin, the lower lip and most of the upper lip. The rest of the head is coal-black.

The body pattern consists of yellow or cream-edged black rings. The black covers from 3 to 3½ scale rows, the cream usually only one-half scale row. The intervening spaces are red in color, forming bands around the body that cover six transverse scale rows. Each red scale bears a black dot.

The black bands are incomplete in the region anterior to the anus, and this space on the venter is creamy white involving parts of four ventrals. Altogether, there are 16 black body bands (including the nuchal) and 15 red bands. On the tail the black bands have wider cream borders and are continuous around the tail; but the last five are reddish dorsally, with rather heavy, dark flecks, and cream on the ventral side.

Scale data: ventrals, 136; caudals, 85; preoculars, 2-1, the lower on the right side small, wedged in between third and fourth labials; supralabials, 8-8; infralabials, 8-8; total length, 541 mm.; tail, 193 mm.

This specimen differs from the southern (Tabasco) specimens in having eight instead of ten labials both above and below. The wide distribution of *laticollaris* with at least two other forms intervening in the territory, *elapoides elapoides* and *elapoides celatus*, strongly suggests that the form should be regarded as a species rather than as a subspecies.

Thamnophis scalaris scaliger (Jan)

Tropidonotus scaliger Jan, Elenco sistematico degli Ofidi, 1863, p. 70. (Type locality unknown.)

Thamnophis scalaris scaliger Smith, Zoologica, vol. 27, 1942, pp. 103-104; Smith and Taylor, U. S. Nat. Mus. Bull., no. 187, Oct. 5, 1945, p. 167 (doubtful reference in San Luis Potosí).

A series of specimens, taken in the general region of Xilitla and Cerro Conejo, are referred to this subspecies.

In four specimens the scale formula is 19-19-17, one only having

16 scale rows anterior to the vent. The upper labials are 8-8, save in one where the number seven occurs on one side. The lower labials are 10-10, with two exceptions; in these nine are present on one side.

The ventral averages are somewhat higher than those given by Smith (*loc. cit.*, p. 103). The ventrals are 151-162; the caudals, 71-72, in males. The ventrals are 151-157; the caudals, 65-66, in females. There is an increase of one in the number of upper labials.

Data on Thamnophis scalaris scaliger (Jan)

No.	*Sex*	*Locality*	*Ventrals*	*Caudals*	*Preoculars*	*Postoculars*	*Temporals*	*Length*	*Length*
291	♀	Cerro Conejo	157	66	1-1	3-3	1 + 2	...	...
292	♂	Cerro Conejo	162	71	1-1	3-3	1 + 2	676	102+
293	♀	Xilitla	154	65	1-1	3-3	1 + 2	612	129
294	♀	Xilitla	151	41+	1-1	3-3	1 + 2	676	102+

Thamnophis phenax phenax (Cope)

Eutaenia phenax Cope, Proc. Acad. Nat. Sci. Philadelphia, vol. 20, 1868, p. 134. (Type locality, Córdoba, Veracruz, México.)

Thamnophis phenax phenax Smith, Zoologica, vol. 27, 1942, pp. 99-100.

Four specimens of this rare snake have been taken in the Xilitla region. One (no. 284) bears the notation "Miramar 4,500 ft."

The scale formula is 19-19-17 in three specimens; one specimen has the rows reduced to 15 in front of vent; supralabials, 8-8; infralabials, 10-10, or 9-10; preoculars, 1; postoculars, 3. The temporals are 1 + 2 (or 1 + 3 in a single instance); loreal, 1; anal single. All show the pattern of large quadrangular blotches.

No. 285 contained the remains of a small terrestrial salamander, which is described elsewhere in this paper.

No. 283 has a median white line dividing the anterior spots, which tend to alternate.

Data on Thamnophis phenax phenax (Cope)

No.	*Sex*	*Locality*	*Ventrals*	*Caudals*	*Body blotches*	*Total length*	*Tail length*
283	♂	Xilitla	151	72	41	548	131
284	♀	Xilitla, Miramar 4,500 ft.	159	62	37	548	105.5
285	yg.	Xilitla	159	75	48	157	48
286	yg.	Xilitla	160	80	41	163	51
287	♂	.....	161	78	41	...	...

Thamnophis marciana (Baird and Girard)

Eutaenia marciana Baird and Girard, Catalogue of North American Reptiles, 1853, pp. 36-37. (Type locality, restricted to Red River, Arkansas. Originally included New Braunfels, San Pedro, and Indianola, Texas.)

Thamnophis marciana Ruthven, U. S. Nat. Mus. Bull., 61, 1908, pp. 849-852, pl. 93.

Smith and Taylor * have regarded a record of this species for San Luis Potosí ** as doubtful. The finding of three specimens in the

* U. S. Nat. Mus. Bull., no. 187, Oct. 5, 1945, p. 164.

** Garman, Bull. Essex Inst., vol. 19, 1887, pp. 7-8.

northeastern part of the state by Mr. Charles R. Shaw and Marcella Newman establishes the species beyond question as a resident of the lowlands in the eastern part of the state. Two were taken November 6, 1946, and one on March 19, 1947. The following data were recorded:

The following scale characters are invariable: scale formula, 21-21-17; supralabials, 8-8; infralabials, 10-10; loreal, 1; anal, 1; 5 scales touching first chinshield. The temporals are 1 + 2, 1 + 3, or 2 + 2.

The lateral light stripe is restricted to the third scale row. A vertebral light (orange) stripe one whole, and two half scale rows wide, is evident the length of the body.

Data on Thamnophis marciana (Baird and Girard)

No.	*Sex*	*Locality*	*Ventrals*	*Caudals*	*Preoculars*	*Postoculars*	*Total length*	*Tail length*
288	♂	Ebano	149	62	1-1	4-4	335	71
289	♀	Ebano	146	58	1-1	4-4	408	89
290	♂	Sabanito	151	69	1-1	3-4	460	110

Storeria dekayi texana Trapido

Storeria dekayi texana Trapido, Amer. Mid. Nat., vol. 31, no. 1, pp. 63-69, figs. 51-60. (Type locality, San Rafael, Jicaltepec, Veracruz, México, alt. circa 100 ft.)

Two specimens from the Xilitla region are referred to this recently described form. The species has been reported from the state on the basis of paratypic * specimens which I collected, 5 miles south of Valles.

Data on Storeria dekayi texana Trapido

No.	*Sex*	*Locality*	*Ventrals*	*Caudals*	*Supra-labials*	*Infra-labials*	*Total length*	*Tail length*
268	♀	Xilitla	141	47	7-7	7-7	350	64
269	♀	Xilitla	141	36+	7-7	7-6	322	50+

The scale formula is 17-17-17; postoculars, 2-2; preoculars, 1-1; temporals, 1 + 2, and 1 + 2, 1 + 3.

Seven of the subcaudals of no. 269 are entire, while the remainder are normally divided; the fifth and fourth labials are fused together. The adult markings are much obscured.

No. 269 contains 8 nearly full-time embryos, which average about 84 mm. in length. Paired spots on the dorsum are evident.

No. 268 contains several eggs, but in none did I discern embryos. This specimen was captured May 13; the other with the embryos was taken June 29.

It is significant that there are two subspecies of *Storeria dekayi* reported from San Luis Potosí. The two specimens of *Storeria*

* These are not specifically designated as paratypes but were dealt with in the type description.

dekayi texana mentioned in the type description "5 miles south of Valles, District Ciudad de Valles EHT-HMS 4662, 2664" were taken in the same pile of driftwood in which was found *Storeria dekayi temporalineata* mentioned in the type description of that form as "five miles south of Valles, EHT-HMS 4663." If these are distinct, one might question the wisdom of regarding them as subspecies. Sufficient material is not at hand to determine this point.

Tantilla rubra Cope

Tantilla rubra Cope, Journ. Acad. Nat. Sci. Philadelphia, ser. 2, vol. 8, 1876. (Type locality, "Tapanatepec" = Tapana, Oaxaca); Smith, Zoologica, vol. 27, 1942, p. 40.

One specimen from the Xilitla region (no. 305 ♂) has the head missing save for certain fragments of skin and one lower jaw.

The scale formula is 15-15-15. The mental is separated from the chinshields. There are 7-7 infralabials, the first four in contact with the first pair of chinshields. There are 157 ventrals, and 64 caudals. The total length (length of head estimated) 345 mm.; length of tail, 85 mm.

The general color is a pinkish brown, the edges of each scale somewhat darker than the center. Ventrals and caudals are pink. The outer half of outer scale row is cream, with a slight wash of pink, scarcely differentiated from the ventral coloration. The upper half of the outer scale row is distinctly darker than adjacent rows. On the tail the lower half of the outer scale row has a small triangular blackish spot on each scale.

A broad, black, nuchal collar is present, three to four scales in width. Preceding this is a cream collar two and one half scale rows wide. A black occipital collar crosses the parietals and reaches to the supralabial edges. A few black spots on infralabials. Other details of the head coloration are wanting.

Tantilla shawi sp. nov.

Type: Louisiana State University Museum no. 306. Collected at Xilitla (Miramar), Aug. 28, 1947, by Charles Shaw.

Diagnosis: A tantilla characterized by seven supralabials, six infralabials, the chinshields separated from the mental; ventrals, 169; subcaudals, 48; anal divided.

Tip of snout black, bordered by a cream band that is followed by a broad black area reaching to the back part of parietals; cream spot behind eye extending from frontal to labials; an occipital cream band one scale wide, followed by a broad nuchal black band four

scales wide. Anterior fourth of body banded with narrow cream and wider black bands.

Description of type: Rostral broader than high, visible above as a very narrow triangle, the summit curved rather than angular; internasals a little less than half area of prefrontals, which are very broad, in contact laterally with second labial; frontal hexagonal, obtusely angled in front, acute behind; distinctly longer than wide (1¼ times), its length greater than its distance from tip of snout, its width not quite twice that of supraoculars; parietals minutely longer than their distance from tip of snout; nasal divided, the anterior part about a half larger than the posterior, and separated from preocular by prefrontal; nostril between two nasals, the posterior widely separated from preocular; one preocular, two postoculars; a large anterior temporal followed by a posterior temporal that is somewhat smaller; supralabials, 7-7, in following order of size: 1, 3, 2, 5, 4, 6, 7, the third and fourth border the orbit; 6-6 infralabials, the first pair separating mental and chinshields; four labials touching the first chinshields, which are nearly three times area of second pair; latter pair in contact; diameter of eye twice in snout length, and one and one-fourth times in eye to nostril distance. Scale formula, 15-15-15; the scales smooth without trace of apical pits; ventrals, 169; caudals, 48; anal divided; total length, 369; tail, 73.5.

Color: Tip of snout blackish, bordered by a cream band that crosses snout, reaching mouth; beginning on the anterior part of the prefrontals and extending to near the posterior tip of parietals, a broad black band reaching on side of head to mouth; a cream spot, covering part of the fourth and fifth supralabials, extends up some distance behind the eye, reaching the frontal; an occipital cream band about one scale wide connects with cream color of chin and throat; this followed by a broad nuchal dark band about three and one half scales wide. The infralabials and mental with variable-sized areas of black, bordered partially by cream; the spot on the fourth infralabial reaches to chinshield; that on fifth small, leaving a large cream area.

General color of body black or bluish black, the edges of the scales faintly outlined in cream or white; scales of outer row with widest light edges; a series of small black dots on outer edge of ventrals (except first 18 or 20) and caudals; venter and subcaudal region light pink; chin and throat cream; anterior fourth of body traversed by narrow transverse cream lines, usually less than one scale wide, and which may be broken mesially and tending to alter-

nate with that from opposite side. There is a suggestion of a discontinuous median line on this part of body.

Relationship: The species differs from all other Mexican species in the character of the annulation of the anterior fourth of the body, and in the details of the head markings.

The Central American *Tantilla annulata* has this tendency to annulation carried still farther back, some of the semiannulations being present on the tail. That form, however, is one of the largest in the genus—a Costa Rican specimen examined having a total length of 502 mm., the tail being 108 mm. The character of the markings, yellow bars with black borders, is such that there is no possibility of confusing the species with *Tantilla shawi.*

The species is named for Mr. Charles Shaw, its discoverer.

Coniophanes imperialis imperialis (Kennicott)

Taeniophis imperialis Girard, The U. S. Naval Astronomical Expedition to the Southern Hemisphere during the years 1849-'50-'51-'52, Reptiles, Senate Doc., no. 121, 1855, p. 215. (Type locality, Matamoros, Tamaulipas, México.)

Coniophanes imperialis imperialis Cope, Ann. Rept. U. S. Nat. Mus., 1898 (1900), p. 1090; Bailey, Papers Michigan Acad. Sci. Arts Lett., vol. 24, pl. 2, 1938 (1939), pp. 34-35, pl. 1, fig. 1, map, fig. 5.

Two specimens (nos. 296, 297) were taken on the lowlands at Ebano in the extreme northeastern part of the state. These agree in the following characters: scale formula, 19-17-15; supralabials, 8-8; infralabials, 9-9; preoculars, 1-1; postoculars, 2-2; temporals, 1 + 2; loreal, 1; anal, 2.

The ventral scale count and measurement in mm. for 296 is 135; caudals 71; total length 398; tail 111; for 297, ventrals 132; caudals 74; total length 140, tail 44. Both are male.

From Bailey's diagnosis of this form, *loc. cit.*, these differ in having 17 scale rows about the middle of the body instead of 19. They agree, however, rather completely in the characteristic color pattern shown in Bailey's illustrations, *loc. cit.*

In 297, a recently hatched specimen, the markings are very sharply defined. The light line through the eye is white, edged with black, and extends along the canthal region and across the snout. The anterior end of the dorsolateral stripes are white, but soon develop posteriorly a scattering of brownish pigment. The lower edge of the white line is bordered by a black line, which is the upper edge of the broad lateral dark stripe that covers 4½ scale rows. The supralabials are bordered above by a black line, below which is a white line. Below this line the lower part of the labials are flecked with black pigment. The chin and infralabials are also flecked with

pigment, and there is a distinct spot on the fifth infralabial. There is a very indefinite pigmented area on the outer edges of the ventrals.

There is no apparent approach to *Coniophanes imperialis clavatus* or *proterops*, forms that occur to the south.

These specimens are the first records of the subspecies for the state.

Coniphanes fissidens proterops (Cope)

C[oniophanes] proterops Cope, Proc. Acad. Nat. Sci. Philadelphia, vol. 12, 1860, p. 249. (Type locality, vicinity of Jalapa, Veracruz.)

Coniophanes fissidens proterops Smith, Proc. U. S. Nat. Mus., vol. 91, 1941, pp. 107-109, map, fig. 33.

A single specimen of this species (no. 295) is in the collection from the Xilitla region. It is the first record of the form for San Luis Potosí.

The specimen shows the following characters: scale formula, 19-19-17; ventrals, 129; caudals, 30 + (tail broken); supralabials, 7, infralabials, 10; preocular, 1; postoculars, 2; temporals, 1 + 2; 5 labials touch first chinshields; length of body 300; tail partially missing.

The median dorsal "black" line consists only of the dark edges of the median dorsal scale row, and taken together the spots have the appearance of a chain.

Trimorphodon tau Cope

Trimorphodon tau Cope, Proc. Amer. Philos. Soc., vol. 11, 1869, pp. 151-152. (Type locality Quiotepec, Oaxaca); Taylor, Univ. Kansas Sci. Bull., vol. 26, 1939 (1940), pp. 474-477, fig. 8, pl. 51.

A single specimen of this species (no. 298), captured two and one-half miles south of Pendencia, San Luis Potosí, December 2, 1946, traces the known range from the southern edge of the plateau, a distance of some three hundred miles. Heretofore the species has been known from possibly half a dozen specimens, with localities in Michoacán, Guerrero, and Oaxaca.

This specimen has been compared with Oaxaca specimens and while a few differences exist it does not appear to merit nomenclatural designation. A larger series from this region might point to a separation.

The specimen is a female having a scale formula 23-21-15 (Oaxaca specimens have 23-20-16 and 22-21-14); ventrals, 218; caudals, 59; anal, 2; supralabials, 8-8; infralabials, 11-11; preoculars, 3-3; postoculars, 3-3; loreals, 3-2; temporals, 2 + 3 + 4, 2 + 2 + 4, somewhat irregularly placed; four infralabials touch chin-

shields; anterior chinshield double the size of posterior; fourth and fifth labials enter orbit; spots on body, 27; 12 or 13 on tail.

The markings of the head and general markings of the body approximate rather closely the pattern depicted by Taylor, fig. 8, *loc. cit.*, and pl. 51. However, the ground color of the specimen is a little darker. The edges of the ventrals have indistinct darker spots which are the ends of the dorsal blotches and small spots that alternate with them. There may be some peppering of pigment on the ventrals, scarcely visible to the naked eye. There are a few indefinite dark marks on the chin.

The following shows the similarity in scale counts between this specimen and two in the EHT-HMS collection (nos. 5506, 5507 from San Felipe, Oaxaca, near the city of Oaxaca). LSU no. 298 ♀ ventrals, 218; subcaudals, 59; total, 277. No. 5506, ♂, ventrals, 206; subcaudals, 70; total, 276. No. 5507, ♀, ventrals, 220; subcaudals, 57; total 277.

Leptodeira maculata (Hallowell)

Megalops maculatus Hallowell, Proc. Acad. Nat. Sci. Philadelphia, vol. 12, 1860 (1861), p. 468. (Type locality, "Tahiti," by error.)

Leptodeira maculata Taylor, Univ. Kansas Sci. Bull., vol. 25, 1938 (1939), pp. 337-342, figs. 6-7, pl. 31, fig. 1; pl. 32; pl. 33, figs. 1-3.

One specimen (no. 299) was taken near Sabanito, El Salto Junction, Naranja Region, San Luis Potosí. The ventrals are 169, the subcaudals 59. Other scale data are: preoculars, 2, postoculars, 3-2; upper labials, 8; lower labials, 10; 26 body spots, 8 caudal spots reaching laterally to the second scale row; scale formula, 23-25-17. The characteristic head marking consists of a white border on the frontal scale, connecting with a line formed by the white edges of the parietals that follows their common suture.

The specimen was taken in "palm jungle by a marsh."

Leptodeira annulata septentrionalis (Kennicott)

Dipsas septentrionalis Kennicott, in Baird, Report of the U. S. Mexican Boundary Survey, vol. 2, 1859, Reptiles, p. 16, pl. 8, fig. 1. (Type locality, Matamoros, Tamaulipas, México, and Brownsville, Texas, U. S. A.)

Leptodeira annulata septentrionalis Smith, Proc. Biol. Soc. Washington, vol. 54, 1941, p. 117.

Six specimens were taken, five from the Xilitla region and one from the extreme northeastern part of the state at Ebano.

The series shows complete uniformity in the following characters: scale formula, 21-23-17; supralabials, 8; infralabials, 10; preoculars, 3; postoculars, 2; scales touching first chinshields, 5.

Smith, *loc. cit.*, has recently described a new form, *Leptodeira*

annulata taylori, from Orizaba, Veracruz, characterized by 196-206 ventrals; 80 to 101 caudals; usually three preoculars, and spots not extending below the third scale row; from 36 to 47 dorsal spots on body.

In the series at hand the spots reach either the first scale row (3 specimens), the second row (one specimen), or the third row (one specimen). The northern *septentrionalis* ordinarily reduce the scale rows to 15 in front of the anus and the spots are usually less than 25—rarely above thirty.

Despite certain differences it seems that the affinities of these specimens are closer to *L. a. septentrionalis* than to *L. a. taylori,* and not impossibly they represent a population similar to that at Tuxpan which Smith, *loc. cit.,* regarded as representing intergrades.

The stomach of no. 300 contained the remains of an unidentified *Sceloporus.* No. 302 had 9 eggs in the oviducts.

Data on Leptodeira annulata septentrionalis (Kennicott)

No.	*Sex*	*Locality*	*Ventrals*	*Caudals*	*Body spots*	*Tail spots*	*Total length*	*Tail length*
300	♂	Ebano	195	83	30	15	386	87
301	yg.	Xilitla	193	94	28	18	420	106
302	♀	Xilitla	193	77	29	12	825	158
303	♀	Xilitla	205	75	29	14	820	156
304	♂	Xilitla	206	66	32	14	818	146

Micrurus fitzingeri microgalbineus Brown and Smith

Micrurus fitzingeri microgalbineus Brown and Smith, Proc. Biol. Soc. Washington, vol. 55, 1942, pp. 63-67. (Type locality, 7 km. south of Antiguo Morelos, Tamaulipas, México.)

The collection contains three specimens of this form which has been known previously from only two specimens, one from the type locality and one from Tamuzunchale, San Luis Potosí.

The following data add considerably to our knowledge of the variation in subspecific characters:

Scale formula: 15-15-15; supralabials and infralabials, 8. Preoculars, 1; postoculars, 2; four scales touch the chinshields. Temporals $1 + 1 + 2$ in two specimens, $1 + 1 + 1$ in the other.

The color pattern is formed by a series of alternating black and red bands, separated by very narrow white bands. Usually the white part consists of separate white spots covering about one half of a scale and not or barely contiguous with the next white spot. As a result of this the red bands appear to have a zigzag edge, while the black bands present an edge that is nearly straight.

The black bands usually cover from three to four scale rows; occasional bands cover only 2½ scale rows. The intervening red bands vary from 6 to 7 scale rows in length. More than half of the

scales of all the rows except the outer have a black spot. The black spots vary much in size, being largest about the middle of the body. A few black spots usually smaller than a dorsal scale are scattered sparsely and irregularly on the ventrals.

The white band crossing the parietal region is half or a little less than half the length of the parietal. It passes somewhat forward involving the entire sixth labial and parts of the fifth and seventh labials. The rest of the upper labials are intensely black. Three white areas present on the chin, the two outer covering parts of the fourth and fifth lower labials, the median, the anterior part of the second pair of chinshields. In one specimen the spots are practically contiguous, thus forming a band entirely around the head.

The female specimen no. 309 has five black and four white bands on the tail, the black being 6 to 6½ scale lengths wide, the white 2 scale rows wide. The males have 6 or 7 black bands on the tail of about the same length as those in the females. The white bands in no. 307 are partially red below and above, and some of the scales bear black spots. No. 308 shows only a faint shade of red on one or two of the white scales.

A specimen (no. 310) of *Micrurus* is referred to this form with considerable reluctance. The white band across the parietals is wider (nearly ⅔ the width of the parietals) involving all the fifth and sixth supralabials and part of the seventh, then passing across the chin involving 5th and 6th infralabials, and most of both pairs of chinshields.

The black blotches on the body are a little wider and occupy four ventrals below, more often than three. The intervening red areas have practically every scale bearing a black fleck, and on the ventrals there is usually a pair of heavy black spots much larger than those on the dorsal part of the red blotches. The neck and body has 20 black blotches, the tail four. There are four white bands on the tail.

The scale data agree with those given for the Xilitla specimens save that ventrals are 222, the caudals 32. The black bands have zigzag rather than straight edges. The snake is 703 mm. in length; the tail 70.

This specimen comes from 17 km. west of Ebano in the northeastern lowlands of the state. It will be noted that the character of the head band suggests the condition that obtains in the typical subspecies *M. f. fitzingeri*. That form is known, however, only from the high plateau.

Data on Micrurus fitzingeri microgalbineus Brown and Smith

No.	*Sex*	*Locality*	*Ventrals*	*Caudals*	*Body bands*	*Tail bands*	*Total length*	*Tail length*
307	♂	Xilitla	204	44	24	7	732	102
308	♂	Xilitla	208	42	27	6	735	93
309	♀	Xilitla	220	38	25	5	625	65

Bothrops nummifer (Rüppell)

Atropos nummifer Rüppell, Verz. Mus. Senck., Amph., 1845, p. 21. (Type locality México.)

Bothrops nummifer Jan, Elenco sistematico degli Ofidi, 1863, p. 126; Smith, Proc. U. S. Nat. Mus., vol. 93, 1943, pp. 398-401.

There are two specimens of *Bothrops,* nos. 318, 319, taken at Xilitla June 19, 1947, that are puzzling, inasmuch as they occur at the extreme northern part of the range of *Bothrops nummifer* (as interpreted by Smith, *loc. cit.,* yet they agree in having certain general characteristics of *B. mexicanus* which tend to separate that form from *B. nummifer.*

In ventral and subcaudal counts the specimens approach the condition in the northern *B. nummifer.* In the scale rows about the body, one approaches *B. nummifer,* one the southern *B. mexicanus.* In the character of the rostral (in contact with the nasal, first labial and two other scales laterally, and with a small median postrostral) they should be referred to *mexicanus.* In dorsal pattern they are more or less intermediate, one approaching the character of *mexicanus,* the other, as regards the fusing of the dorsal blotches into a zigzag or undulating band, is quite like *nummifer.*

However, I feel that a larger series of specimens should be examined before it is decided whether or not this is an "intergrading" population.

No. 318 contained a "⅓ grown black rat."

Data on Bothrops nummifer (Rüppell)

No.	*Sex*	*Scale formula*	*Ventrals*	*Caudals*	*Supra-labials*	*Infra-labials*	*Total length*	*Tail length*
318	♂	25-25-20	134	33	10-9	12-11	661	75
319	♂	23-23-19	131½	33	9-9	11-10	520	62

Bothrops atrox asper (Garman)

Bothrops atrox Duméril, Bibron and Duméril, Erpétologie générale, vol. 7, pl. 2, 1854, pp. 1507-1509. (Type locality, Obispo, Panamá.)

Bothrops atrox asper Smith and Taylor, Bull. U. S. Nat. Mus., no. 187, 1945, pp. 180-181.

Seven specimens were taken, three at El Salto, three at Xilitla. The subcaudals in all are in a double row. One or two scale rows intervene between the long subocular and the labials. The number of loreals varies between three and four. There are two preoculars, two postoculars, and usually 10 or 11 scales between the supra-

oculars. No. 311 has the first pair of infralabials broken, forming an extra pair of "chinshields."

Data on Bothrops atrox asper (Garman)

No.	Locality	Sex	Scale formula	Ventrals	Caudals	Supra-labials	Infra-labials	Total length	Tail length
311	El Salto	♀	27-28-19	205	62	7-8	11-10	789	109
312	Xilitla	..	27-25-20	203	63	7-7	10-11	1282	176
313	Xilitla	♂	25-25-20	205	70	7-7	11-11	1035	150
314	Xilitla	..	25-29-18	203	63	7-8	10-11	1025	127
315	El Salto	..	28-29-21	209	63	7-8	10-11	890	112
316	El Salto	♂	28-25-21	210	67	7-7	10-10	854	120
317	.....	♂	28-25-21	204	68	7-7	10-10	1410	195

Crotalus triseriatus triseriatus Wagler

Urosophus triseriatus Wagler, Natürliches System der Amphibien, 1830, p. 176. (Type locality México.)

Crotalus triseriatus triseriatus Klauber in Githens and George, Bull. Antiv. Inst. America, vol. 5, 1931, p. 33 (part); Gloyd, Chicago Acad. Sci. Spec. Publ., no. 4, 1940, pp. 84-91, map 6, pl. 6, fig. 1, 2; pl. 31, fig. 4 (reported from Alvarez, San Luis Potosí).

Ten specimens of *Crotalus* in the collection are referred to this species. Of the ten specimens, eight are from the Xilitla region, at an elevation from about 3,800 feet to 4,400 feet; two are from Cerro Conejo at a somewhat higher elevation. For the most part, the specimens are uniform in color and markings, and agree in having a series of from 36 to 44 quadrangular blotches on the body, and from 5 to 7 on the tail. However, one of the series (no. 321) differs markedly in having the head and body an almost uniform, slaty black. On the posterior sixth of the back, a few very dim lighter narrow marks can be discerned with difficulty when the specimen is held in the proper light.

The ventrals are less intensely dark than the other specimens and have lighter edges. The tail has some dim orange coloration ventrally and laterally. The keels on the scales are seemingly less strongly elevated than those on the remainder of the series. The scale counts of the specimen, however, fall within the known variation of the species. No melanistic specimens have heretofore been reported, although certain other aberrant specimens have been cited by Gloyd, *loc. cit.* This specimen contained a partially digested salamander in its stomach and very numerous tapeworms.

The ventral scale series, whether male or female, averages 154. This is the average given by Gloyd for the San Luis Potosí specimens.

One specimen (no. 325) presents a curious anomaly, in having the lower preocular completely absent. As a consequence, the orbit and the sensory pit are confluent. The pit itself is divided into two compartments by a heavy membrane. This condition obtains on both sides of the head.

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A Review of the Lizard Genus *Barisia*

BY

J. A. TIHEN

ABSTRACT.—The generic name *Barisia* is revived for a group of lizards that in recent years has been placed in the genus *Gerrhonotus*. The following species and subspecies are recognized: *Barisia moreleti moreleti, B. m. temporalis, B. m. salvadorensis, B. m. fulva, B. m. rafaeli, B. monticola, B. viridiflava, B. gadovii gadovii, B. g. levigata, B. modesta, B. antauges, B. rudicollis, B. levicollis, B. imbricata imbricata, B. i. ciliaris, B. i. planifrons.*

The various groupings within the genus are discussed. Brief descriptions are given of all the forms with their present known distribution.

A review of the lizard genus *Barisia*

BY

J. A. TIHEN

The genus *Barisia* was proposed by Gray in 1838 to contain three species formerly included in the genus *Gerrhonotus* Wiegmann; these species were *B. rudicollis, B. imbricata,* and *B. lichenigera; B. adspersa* was included as a synonym of the last-named species. The same arrangement appeared in his 1845 Catalogue, but he there changed the spelling from *Barisia* to *Barissia;* this emended spelling has incorrectly been used by all subsequent authors.

This genus has been recognized as valid by some authorities, relegated to the synonymy of *Gerrhonotus* by others, and considered as a subgenus of *Gerrhonotus* by yet others. It was redefined by Cope in 1877 on the basis of the arrangement of the "internasal" and frontonasal elements. He recognized five species: *antauges, bocourti, lichenigera, imbricata,* and *rudicollis.* In the same work he proposed the genus *Mesaspis* for two forms, *moreleti* and *fulvus.* Most authors have never considered this latter a valid genus, al-

though Cope still recognized it in 1900; recent workers have also tended to return *Barisia* to the synonymy of *Gerrhonotus*.

I have recently * set forth my reasons for believing that *Barisia* should be considered a valid and recognized genus of gerrhonotine lizards, and have redefined the genus as shown below. A discussion of the genus as a whole, in relation to other gerrhonotine genera, is to be found in the previous paper; the present paper deals with the forms and interrelationships within the genus.

I wish to express my appreciation for the many helpful suggestions and criticisms offered during the course of my study and the preparation of this paper by Dr. S. C. Bishop of the University of Rochester and Dr. Hobart M. Smith of the University of Illinois, also by Dr. E. R. Dunn of Haverford College and Drs. L. C. Stuart and Norman Hartweg of the University of Michigan. The following individuals have been very generous in lending personal specimens, or specimens under their care in the institutions with which they are connected: Dr. Doris M. Cochran of the U. S. National Museum, Mr. Charles M. Bogert of the American Museum of Natural History; Mrs. Helen T. Gaige and Dr. Norman Hartweg of the University of Michigan, Dr. Edward H. Taylor of the University of Kansas, Mr. Karl P. Schmidt of the Chicago Natural History Museum, Sr. Rafael Martín del Campo of the Instituto de Biología of Mexico, Mr. R. T. Moore of the California Institute of Technology, Mr. Arthur Loveridge of the Museum of Comparative Zoölogy, and Dr. E. R. Dunn of the Philadelphia Academy of Natural Sciences.

The following abbreviations will be used throughout this paper in reference to the various collections examined:

AMNH American Museum of Natural History.
ANSP Academy of Natural Sciences of Philadelphia.
CNHM Chicago Natural History Museum.
EHT-HMS Personal collection of Dr. Edward H. Taylor.
IBM Instituto de Biología de Mexico.
MCZ Museum of Comparative Zoölogy.
RTM Personal collection of R. T. Moore.
TAM Texas A & M College.
UMMZ University of Michigan Museum of Zoology.
USNM United States National Museum.

* Amer. Mid. Nat. 1949 in press.

Barisia Gray

Barisia Gray, 1838, Ann. Mag. Nat. Hist., ser. 1, 1:390.
Tropidogerrhonotus Fitzinger, 1843, Syst. Rept.:21. (genotype—*rudicollis*)
Barissia Gray, 1845, Cat. Spec. Liz. Coll. Br. Mus.:54.
Tropidogerrhum Agassiz, 1846, Nomencl. Zool., Ind. Univ.:203. (genotype—*rudicollis*)
Mesaspis Cope, 1877, Proc. Amer. Philos. Soc., 17:96. (genotype—*moreleti*)

Genotype: *Gerrhonotus imbricatus* Wiegmann, 1828 [= *Barisia imbricata imbricata* (Wiegmann)].

Definition: Gerrhonotine lizards with the skull not widened or depressed; frontal bone not in contact with the maxillae; pterygoid teeth absent or vestigial; dorsal osteoderms with a well-defined, strongly thickened basal area; lateral fold moderately to well developed, with a moderate or large granular area; sides of the neck finely granular; postero-ventral surfaces of the forearms and shanks granular; minimum number of scales in a single row across the nape six to ten; anterior internasals present; postrostral present or absent; subocular and postocular series well differentiated from each other; the suboculars extend to the lowest primary temporal; twelve to fourteen ventral scale rows.

Range: Panamá northward through Central America and México to Chihuahua and Coahuila.

A full description of the genus may be found in my previous paper referred to above; it will not be repeated here.

There are three major lines of specialization within the genus; these have given rise to three species groups, which may be defined very briefly as follows:

1. Postmental unpaired; superciliary series usually complete ..... *moreleti* group
2. Postmental paired; superciliary series complete... *gadovii* group
3. Postmental paired; superciliary series incomplete ..... *imbricata* group

A KEY TO THE FORMS OF THE GENUS *Barisia*

1. Postmental unpaired (nasal bones in contact)..... 2
   Postmental paired; (nasal bones separated by fronto-premaxillary contact)..... 8
2. Eighteen to twenty longitudinal dorsal scale rows..... 3
   Fourteen to sixteen longitudinal dorsal scale rows..... 7
3. Upper and lower postnasals in contact..... 4
   Upper postnasal separated from lower by a loreo-nasal contact..... *moreleti rafaeli*
4. Lowest primary temporal usually in contact with only the lowest secondary; prefrontals usually absent; posterior loreal usually not in contact with the supralabials 5
   Lowest primary temporal usually in contact with the two lower secondaries; prefrontals usually present; posterior loreal normally in contact with the supralabials 6
5. Anterior superciliary element frequently in contact with prefrontal; frontonasal usually touching frontal; 52-58 dorsal scale rows..... *moreleti temporalis*

Anterior superciliary element not in contact with prefrontal; frontonasal usually separated from frontal by prefrontals; 47-55 dorsal scale rows..... *moreleti salvadorensis*

6. Anterior sublabial usually in contact with the second infralabial; general color frequently brownish ..... *moreleti fulva*
   Anterior sublabial usually in contact with only the third, or more posterior, infralabial; general color usually olive to blackish..... *moreleti moreleti*
7. Usually 16 dorsal scale rows; frontonasal present, large..... *monticola*
   Fourteen dorsal scale rows; frontonasal normally absent..... *viridiflava*
8. Superciliary series complete; (pterygoid teeth absent)..... 9
   Superciliary series incomplete; (pterygoid teeth vestigial)..... 12
9. Supranasals unexpanded; an anterior canthal present..... 10
   Supranasals expanded; no anterior canthal..... 11
10. Scales of neck keeled; anterior loreal in contact with anterior canthal.. *gadovii gadovii*
    Scales of neck smooth; anterior loreal separated from anterior canthal by a contact of the posterior loreal with the upper postnasal..... *gadovii levigata*
11. Frontonasal and postrostral present..... *modesta*
    No frontonasal or postrostral..... *antauges*
12. One loreal; more than 33 dorsal scale rows..... 13
    Two loreals; fewer than 33 dorsal scale rows..... *rudicollis*
13. More than one (usually three) superciliaries; transverse dorsal scale rows fewer than 46 14
    A single (middle) superciliary element; transverse dorsal scale rows 46 or more... *levicollis*
14. Fewer than 16 longitudinal dorsal scale rows; contact of the anterior superciliary with the loreal usually smaller than that of the first medial supraocular with the loreal ..... *imbricata imbricata*
    Sixteen longitudinal dorsal scale rows; contact of the anterior superciliary with the loreal as great or greater than that of the first medial supraocular with the loreal 15
15. Lowest primary temporal in contact with the penultimate as well as the antepenultimate supralabial; 39-45 transverse dorsal scale rows..... *imbricata ciliaris*
    Lowest primary temporal not in contact with the penultimate supralabial; 35-39 transverse dorsal scale rows..... *imbricata planifrons*

The *moreleti* group

Definition: *Barisia* with an unpaired postmental; nasal bones in contact with each other in the mid-dorsal line; pterygoid teeth absent; small lizards, the snout-vent length never exceeding 95 mm., usually much less; dorsal color dark olive brown or brown to blackish, with a more or less well-defined dorsal longitudinal band; venter usually spotted or mottled with dark; superciliary series usually complete; upper postnasal present; loreo-canthal series variable; frontonasal and postrostral present or absent; lateral fold moderately developed.

Range: Panamá northward to Oaxaca.

Discussion: The possession of an unpaired postmental is a universal characteristic of the group. The nasal bones are known to be in contact in *viridiflava* and *m. moreleti;* this is assumed to be the condition in the other members. Some examples of all species (but not of all subspecies) have been examined to determine the condition of the pterygoid, and in all cases the pterygoid teeth were completely lacking.

These are the smallest of all the Gerrhonotinae; the largest species of the group is *moreleti* itself, with a maximum observed snout-vent length of 92 millimeters. *B. viridiflava* is the smallest form, with an observed maximum of 71 mm. The color pattern, though varying in detail, is basically similar in all members of the group. A similar type of pattern is found in the *gadovii* group, but the *imbricata* group is, in general, much lighter, with a strong tendency towards obliteration of the dorsal longitudinal band.

The arrangement of the lateral supraoculars and the superciliary series merits some discussion. In the majority of specimens of *moreleti* there are three lateral supraoculars and a normal, complete superciliary series. In *viridiflava* and *monticola* the usual condition appears to be the possession of only two lateral supraoculars, with the superciliary series complete and the most posterior element occasionally somewhat enlarged. In some specimens of *moreleti* and *monticola* an arrangement is found which appears very similar, but which seems better interpreted as a loss of the posterior part of the superciliary series, the third lateral supraocular dropping down to contact the orbit. A very similar condition is found throughout the *imbricata* group. Neither interpretation—the loss of the posterior superciliaries or the loss of the third lateral supraocular with an enlargement of the most posterior superciliary—adequately accounts for all the conditions found. I have used the latter interpretation to explain the arrangement as found in *viridiflava*, the former to explain the slightly different one found occasionally in other members of this group and universally in the *imbricata* group. Possibly neither is entirely correct.

In the present group, the upper postnasal is always present, although not necessarily in contact with the lower. The supranasal is variable, usually present and unexpanded, but sometimes absent in certain forms, and occasionally expanded in others. The loreocanthal group is quite variable in *moreleti* itself but usually containing at least three elements, while in other species, only one or two elements are usually present.

The group as a whole shows a strong tendency towards enlargement of the frontonasal, with corresponding reduction of the posterior internasals and, more particularly, the prefrontals; these latter are in some cases completely lacking, either dropped out or fused with the enlarged frontonasal. In one form, *viridiflava*, modification has been in the opposite direction; the frontonasal is absent or, in those exceptional individuals where it does occur, is

relatively small. The postrostral is normally lacking in all forms, but appears in occasional specimens of *viridiflava*.

The dorsal osteoderms are rather thin, slightly rugose, with a strongly thickened basal portion and a rather weak and obtuse median keel. The lateral fold is only moderately developed, the included granular area being about equivalent to one lateral scale row in width. The side of the neck contains a very poorly-defined dermal pocket or none at all.

The *moreleti* group, particularly the species *moreleti*, is thought to be the most primitive of the genus. The unpaired postmental, reduction of the prefrontals, and complete lack of pterygoid teeth are modifications not found in the primitive *Barisia* stock, but in totality of characters this group approaches that stock more closely than does any other.

I do not at present propose to enter into great detail regarding subspecific differentiation within the species *Barisia moreleti*. There is much individual variation in this form, and the localities from which collections of series of individuals have been made are so scattered that areas of intergradation cannot yet be definitely established. The taxonomic arrangement is therefore far from settled, and I prefer to give at present only a brief resumé of those forms which I believe to be valid subspecies.

Barisia moreleti moreleti (Bocourt)

Gerrhonotus moreleti Bocourt, 1871, Nouv. Arch. Mus., 7, Bull.:102.
Gerrhonotus moreletii, Bocourt, 1871, *ibid.*:103.
Mesaspis moreletii, Cope, 1877, Proc. Amer. Philos. Soc., 17:96.
Gerrhonotus [*moreletii*] *moreletii*, Dunn and Emlen, 1932, Proc. Acad. Nat. Sci. Philad., 84:29.

Type and type locality: A series of specimens presumably in the Paris Museum. From "le Peten, ainsi que les forêts de pins de la Haute Vera-Paz (Guatémala)."

Range: Alta Verapaz, Guatemala, westward possibly to, but not beyond, the Cuchumatanes, and southward into Honduras, where presumed intergrades with *salvadorensis* are found.

Diagnosis: A *Barisia* of the *moreleti* group with 18-20 longitudinal rows of dorsals; transverse rows of dorsals 49-56; lowest primary temporal in contact with only the lowest secondary; supranasals present, unexpanded; frontonasal present, large, usually in contact with the frontal; prefrontals usually absent; upper and lower postnasals in contact with each other; anterior superciliary not in contact with prefrontal (when present); posterior loreal usually separated from the supralabials; sublabial series usually

extending anteriorly only to the third or a more posterior infralabial; dorsal color usually dark brown or olive brown to blackish; venter usually relatively dark in color, with a rather conspicuous light V-shaped marking on the chin.

Barisia moreleti fulva (Bocourt)

Gerrhonotus fulvus Bocourt, 1871, Nouv. Arch. Mus., 7, Bull.:104.
Mesaspis fulvus, Cope, 1877, Proc. Amer. Philos. Soc., 17:96.
Gerrhonotus moreletii fulvus, Stuart, 1943, Occ. Pap. Univ. Mich. Mus. Zool., No. 471:20.

Type and type locality: A series in the Paris museum; from "les forêts de pins de Totonicapan (Guatemala)."

Range: Northwestern Guatemala, the limits of the range not established. Specimens from the Sierra de los Cuchumatanes are not fully typical of this form; they may possibly represent three-way intergradation—*moreleti, m. fulva* and *m. temporalis*, but they also present certain unique characteristics, indicating that the situation may be even more complex.

Diagnosis: Similar to *B. m. moreleti*, except: transverse rows of dorsals 50-59; sublabial series usually extending anteriorly to touch the second infralabial; color generally somewhat lighter, more brownish dorsally; venter also somewhat lighter, therefore the V-shaped marking on the chin less conspicuous.

Note: If the locality data concerning the type are correctly given by Bocourt, the name *fulva* seems the most likely name for this western Guatemala subspecies. However, the figure of this form subsequently published by him in his "Mission Scientifique," Pl. 21b, figs. 6, 6a, shows certain features definitely not characteristic of the population to which the name is here assigned. Since these features were not mentioned in the original description, further study is required to determine whether or not the figure actually represents one of the type series of *fulva*, and if so, whether it is only an aberrant individual or is typical of that series, and whether or not the locality data are correct, before a certain assignation of the name can be made. Since this certain assignation cannot be made at present, I believe it will cause the least confusion to continue, for the present, to apply this name to the western Guatemala form.

Barisia moreleti rafaeli (Hartweg and Tihen)

Gerrhonotus moreleti rafaeli Hartweg and Tihen, 1946, Occ. Pap. Univ. Mich. Mus. Zool., No. 497:8.

Type and type locality: UMMZ 88228; a young female from 16 km. S of Siltepec, Chiapas.

Range: The southern Sierra de Chiapas. Known from the following localities: 16 km. S of Siltepec, Chiapas (UMMZ 88227-88228), Cerro Paxtal (UMMZ 88384), Chiquihuite, Volcán de Tacaná (UMMZ 88384), Cerro Malé (UMMZ 94290), and Volcán Tajumulco, Guatemala (CNHM 20308-20310).

Diagnosis: Similar to *B. m. moreleti* except: dorsals in 50-55 transverse rows; prefrontals present; upper and lower postnasals separated from each other by the anterior loreal, which is in contact with the nasal; posterior loreal in contact with the supralabials; V-shaped marking on chin less distinct, the marking itself being darker than in *m. moreleti.*

Barisia moreleti salvadorensis (Schmidt)

Gerrhonotus salvadorensis Schmidt, 1928, Field Mus. Nat. Hist. Zool. Ser., vol. 12, no 16, 196.

Gerrhonotus moreletii salvadorensis, Dunn and Emlen, 1932, Proc. Acad. Nat. Sci. Phila 84, p. 28.

Type and type locality: CNHM 10957; an adult female from Los Esesmiles, dept. Chalatenango, Salvador.

Range: Honduras and Salvador southward to Matagalpa, Nicaragua.

Diagnosis: Similar to *B. m. moreleti,* except: transverse rows of dorsals 47-55; lowest primary temporal usually in contact with the two lowest secondaries; frontonasal usually separated from the frontal by the prefrontals, which are consistently present; posterior loreal in contact with the supralabials; sublabials extending anteriorly to touch the second infralabials.

Barisia moreleti temporalis (Hartweg and Tihen)

Gerrhonotus moreleti temporalis Hartweg and Tihen, 1946, Occ. Pap. Univ. Mich. Mus. Zoöl., No. 497:10.

Type and type locality: UMMZ 94910; an adult male, collected 11 km. southeast of Ciudad de las Casas, Chiapas.

Range: Known only from the vicinity of Ciudad de las Casas, Chiapas.

Diagnosis: Similar to *B. m. moreleti,* except: 52-58 transverse rows of dorsals; lowest primary temporal usually in contact with the two lowest secondaries; prefrontals present, sometimes separating frontonasal from frontal; anterior superciliary frequently in contact with prefrontal; posterior loreal in contact with the supralabials; sublabials extending anteriorly to the second infralabial; dorsal and ventral coloration both decidedly lighter in tone, the

V-shaped chin marking less conspicuous because of the lighter background.

General remarks: The species *moreleti* is the most generalized member of the group, and of the genus *Barisia*. This is demonstrated by the high number of dorsal scale rows, the possession of three lateral supraoculars and a complete superciliary series, the relatively large number of loreo-canthal elements, and the general coloration. There are, of course, certain features considered as highly modified, particularly the reduction or loss of the prefrontals and, in common with the other members of the group, the complete lack of pterygoid teeth and the possession of a single postmental.

Barisia monticola (Cope)

Plate II, figs. 1, 2

Gerrhonotus monticolus Cope, 1877, Proc. Amer. Philos. Soc., 17:97.

Gerrhonotus alfaroi Stejneger, 1907, Proc. U. S. Nat. Mus., 32 no. 1542:505. (Type locality: Santa María [de Dota], Costa Rica.)

Type and type locality: In the collection of the U. S. National Museum; number not designated by Cope. From the summit of Pico Blanco in Costa Rica.

Range: The mountains of western Costa Rica south to Chiriquí, Panamá.

Diagnosis: A *Barisia* of the *moreleti* group with sixteen longitudinal rows of dorsals (the most lateral occasionally much reduced); transverse rows of dorsals 43-51; supranasals present or absent; frontonasal present; prefrontals present, often much reduced, or occasionally absent.

Description: No postrostral. Nasal normally separated from rostral by the anterior internasals. Supranasals usually absent. Frontonasal present, large, in contact with the frontal or not; prefrontals usually present, often much reduced. Loreo-canthal region variable, but seldom more than two elements present. One preocular; two or three suboculars; two to four postoculars. Three to five superciliaries, the series complete posteriorly, with the posterior element frequently much enlarged; two, sometimes three, lateral supraoculars. Four primary and four secondary temporals, the uppermost primary in contact with the uppermost secondary or not, and the lowest primary normally in contact with only the lowest secondary, occasionally the two lowest. Supralabials 8-10; infralabials 7-9. Postmental unpaired, followed by three large pairs and one smaller pair of chin shields, of which the members of the first, occasionally also the second, pair are in contact along the mid-

ventral line. The sublabials extend anteriorly to the first chin shields (rarely the postmental) and the second infralabials.

Dorsals in sixteen longitudinal rows, the most lateral occasionally reduced, and 43-51 (ave. 47.7) transverse rows. Ventrals in twelve longitudinal and 51-57 (ave. 53.9) transverse rows. Caudal whorls 78-87 (ave. 83.1). The median six or eight rows of dorsals are rather weakly and obtusely keeled.

There is a marked sexual dimorphism in the color pattern. Males black or brownish-black dorsally, with many small bluish-white spots (green in life), these spots somewhat larger and more distinct dorsally than laterally, producing a poorly defined dorsal longitudinal band. A latero-dorsal dark line bordering this band, and an interrupted mid-dorsal dark stripe. Ventral surface mottled (yellow green in life), the chin and throat frequently lighter than the belly; a more or less distinct V-shaped mark along the chin shields. Females a much lighter brown, with the whitish spots less numerous or lacking. The dorso-lateral dark line is very prominent, often bordered above by a narrow light line. A similarly prominent interrupted mid-dorsal stripe. Belly much lighter than in males, tending towards a uniform grayish and not prominently mottled.

These are small lizards, averaging around 78 mm. in snout-vent length; the observed maximum is 87 mm. Tail 1.58-1.68 times the snout-vent length.

Remarks: This species shows certain resemblances to *B. morcleti,* but differs from that species in the smaller number of dorsal scale rows, both transverse and longitudinal, and in color pattern, particularly of the males. It also differs in the frequent absence of supranasals. Although the loreo-canthal region is somewhat variable within both species, there is a definite tendency for *monticola* to possess a smaller number of elements in this region. The number of supralabials is, in *monticola,* most frequently nine, in *moreleti* most frequently ten. In view of the lack of intergrading specimens and the fairly numerous and constant differences between *monticola* and all races of *moreleti,* it seems best for the present to retain full specific rank for *monticola.*

Certain variable features within this species give indications that they may possess geographic significance. The presence or absence of supranasals and the contact or lack of a contact of the uppermost primary with the uppermost secondary temporal may also prove to have geographic significance. Material at present avail-

able, is however, inadequate to conclusively demonstrate the existence of more than one race.

Specimens examined: Costa Rica: Barba (MCZ 28077-28078); Irazú (MCZ 15465, 15468, 32079); Poas (MCZ 15466-15467); Cerro de las Vueltas (USNM 70649); Volcán Irazú (20) 8,000-10,000 ft.; Volcán Poas (3) 6,300 ft. Cerro de la Muerte (1) 11,000 ft. (uncatalogued specimens). Specimens have also been reported from Pico Blanco and Santa María, Costa Rica. *Panamá*: Chiriquí Volcano (MCZ 45664; USNM 94991).

Barisia viridiflava (Bocourt)

Figure 1

Gerrhonotus viridiflavus Bocourt, 1873, Ann. Sci. Nat., ser. 5, 17, art. 2 (unpaged).

Gerrhonotus bocourti Peters, 1877, Monatsber. K. Preus. Akad. Wiss. Berlin, 1876:297. (Type locality: "Mexico.")

Barissia bocourti, Cope, 1877, Proc. Amer. Philos. Soc., 17:97.

Gerrhonotus obscurus Günther, 1885, Biol. Centr. Amer., Rept.: 40. (Type locality: "Mexico.")

Type and type locality: In the Paris Museum, number unknown. The locality is given merely as "Mexique," but in view of the present known distribution, I propose to restrict the type locality to "the highlands of central Oaxaca."

Range: Highlands of central Oaxaca.

Diagnosis: A *Barisia* of the *moreleti* group with fourteen longitudinal rows of dorsals; transverse rows of dorsals 48-54; supra-

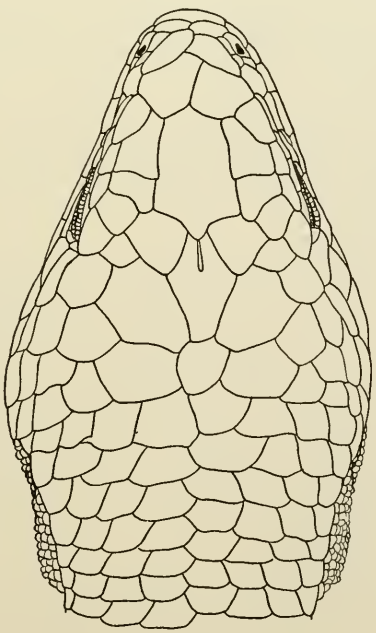

FIG. 1. *Barisia viridiflava* U. S. National Museum no. 113220. Actual snout to ear measurement—13.8 mm.

nasals present, expanded or not; frontonasal normally lacking; prefrontals present, not reduced in size.

Description: Postrostral present or absent; occasionally two anterior internasal elements present on each side. Supranasals present, occasionally expanded to meet the postrostral (when present) or, more rarely, to meet each other in the mid-dorsal line. Frontonasal normally absent, rarely present. One loreal; no canthals. The usual arrangement of the scales above the eye is interpreted as follows: two lateral supraoculars; the superciliary series is complete, with the most posterior element usually somewhat enlarged. Three to five superciliaries, the most anterior only rarely in contact with the prefrontal. Suboculars two; postoculars three. Normally four primary and four secondary temporals, the uppermost primary occasionally in contact with the uppermost secondary, more frequently not, and the lowest primary in contact with only the lowest secondary. Nine, occasionally eight, supralabials; seven or eight infralabials. Postmental unpaired, followed by three large pairs and one much smaller pair of chin shields, of which the members of the anterior pair are in contact mid-ventrally; the members of the second pair are frequently in contact with each other posterior to a single small median scale intercalated between these and the first pair. The sublabials extend anteriorly to the first chin shield and second infralabial.

Dorsals in fourteen longitudinal and 48-55 (av. 51.6) transverse rows; ventrals in twelve longitudinal and 55-61 (av. 57.9) transverse rows. Caudal whorls 83 and 87 in the only two specimens seen with undamaged tails. The median six or eight rows of dorsals are rather weakly keeled.

Color pattern similar in general to that of *B. m. moreleti,* but with great variation in details. The dorsal longitudinal band may be very prominent or very poorly defined; the sides may show very many or practically no white-tipped scales; the belly is usually very dark, but occasionally a very light gray, and may be strongly mottled or nearly uniform. These variations do not seem to be correlated with age, sex, or locality, excepting that the Mt. Zempoaltepec specimens have, on the whole, a better defined pattern, with stronger contrasts between the various elements, than do specimens from other localities.

This is the smallest of all the gerrhonotine lizards, adults averaging slightly over 60 mm. in snout-vent length, with an observed maximum of 71 mm. Tail 1.55-1.67 times the snout-vent length.

Remarks: Since the characters presumably distinguishing the three forms, *viridiflava, bocourti* and *obscurus* are all found in a single series of specimens from a single locality (Cerro San Felipe), and since specimens from other localities show no evidence of any geographic significance in these variations, I consider the three names synonymous, with *viridiflava* having priority.

The species is certainly a member of the *moreleti* group, but differs rather widely from the other members, and is considered to be the most highly modified form in the group. The low number of longitudinal dorsal scale rows, the constant absence of all but one loreo-canthal element, the small size, the usual absence of the frontonasal, the usual occurrence of only two lateral supraoculars, and the relatively low number of supralabials are all considered specialized characters, and are the ones which serve to distinguish this form from the other members of the group.

Specimens examined: Oaxaca. Mt. Zempoaltepec (RTM 394, 403-404, 406; USNM 47184-47185, 47599); Cerro San Felipe (EHT-HMS 19146-19149, 23810-23835); Chivato (EHT-HMS 28133-28134); Cuicatlan (USNM 47612). A total of forty specimens; no other specimens with definite locality data have been reported.

The *gadovii* group

Definition: Barisia with a paired postmental; nasal bones separated from each other by a narrow contact of the frontal with the premaxilla; lizards of small to moderate size, not exceeding 110 mm. in snout-vent length; coloration similar to that of the *moreleti* group, but with a greater tendency for vertical bars along the sides, occasionally continued across the back; superciliary series complete; upper postnasal present; usually (?) two loreals; an anterior canthal may or may not be present; frontonasal and postrostral present or not; lateral fold moderately developed.

Range: Southern Guerrero through Oaxaca to Veracruz.

Discussion: I have chosen to term this group the *gadovii* group, rather than assign to it the older name of *antauges,* because the latter form is so poorly known that its affinities are uncertain. It has been tentatively referred to this group on the basis of its possession of a paired postmental; the same is also true of *B. modesta.* Since these forms are so inadequately known, the group has been defined chiefly on the basis of the species *gadovii.* Further information concerning these other forms may require a modification of this definition, or may show that they have been incorrectly assigned to this group.

The *gadovii* group is in many respects intermediate between the

moreleti and *imbricata* groups, morphologically as well as geographically. It possesses the relatively liberal scalation and general color pattern of the former, and also resembles that group in the relatively weak development of the lateral fold and the complete lack of pterygoid teeth. It agrees with the *imbricata* group in the possession of a paired postmental and in the important osteological feature of the separation of the nasals by a fronto-premaxillary contact, though this separation is narrower here than in the *imbricata* group. In size and color pattern it is also more or less intermediate between the other two, but closer to the *moreleti* group.

Barisia gadovii gadovii (Boulenger)

Gerrhonotus gadovii Boulenger, 1913, Ann. Mag. Nat. Hist., ser. 8, 12:564.

Type and type locality: A series of specimens in the British Museum, no holotype designated. This series is from Omilteme, Guerrero.

Range: Known only from the vicinity of Omilteme, Guerrero, but possibly ranging southward into Oaxaca.

Diagnosis: A *Barisia* of the *gadovii* group with a frontonasal; supranasals small, unexpanded; lateral scales as well as dorsal scales of body keeled; those of neck also with keels; usually two loreals and one (anterior) canthal, the latter in contact with the anterior loreal; belly spotted or mottled with black; dorsal color a dark brownish gray or brownish black.

Description: Postrostral present or absent. Supranasals present, small, unexpanded. Frontonasal present, in contact with the anterior canthal and often with the frontal. Two loreals and one (anterior) canthal, the latter normally in contact with the anterior loreal. Normally three lateral supraoculars. Superciliaries three to six, the most anterior not in contact with the prefrontal. Usually one preocular, one subocular, and two or three postoculars. Four primary and four secondary temporals, the uppermost primary usually in contact with the uppermost secondary, and the lowest primary with only the lowest, occasionally also the second, secondary. Supralabials 8-10; infralabials 7-9. Postmental paired, followed by three large pairs and one smaller pair of chin shields, of which the members of the first pair, frequently also the second, are in contact along the mid-ventral line. The sublabials extend anteriorly to the first chin shields and second infralabials, occasionally the postmental and/or first infralabial.

Dorsals in 16-18 longitudinal and 46-51 (ave. 48.4) transverse

rows; ventrals in twelve longitudinal and 52-56 (ave. 53.9) transverse series. Occasionally some of the transverse rows of ventrals contain only ten or eleven scales. Caudal whorls 78-88 (ave. 84.2). Usually all or nearly all of the dorsal scales are prominently keeled, as are those of the sides of the tail and one or two rows on the thigh and on the shank.

A dark brownish gray or brownish black dorsally, often with a more or less distinct longitudinal band. Narrow vertical black bars on the sides, usually bordered posteriorly with white; these bars may be continued across the back as obtusely V-shaped markings. There are about twelve such bars between the axilla and the groin. Venter heavily spotted or mottled with black in males, lightly in females. A dark line from the nasal across the eye onto the temporals, bordered below by a very prominent light stripe.

This form is of moderate size, adults averaging about 90 mm. in snout-vent length, the observed maximum being 102 mm. Tail 1.44-1.72 (ave. 1.59) times the snout-vent length.

Remarks: The species *gadovii* does not appear to be particularly closely related to any other. Oaxacan specimens represent a different form, but are thought to constitute a subspecies of *gadovii* rather than a distinct species; differences are discussed in connection with that form.

There is a slight superficial resemblance between this form and *Elgaria multicarinata* of the United States Pacific Coast. Some *multicarinata* reported from "Mexico" may well be referable to this form. In this connection, there can be little doubt that the figure of a skull in Bocourt's "Mission Scientifique" (Pl. 21c, fig. 7, 7a) and labelled "multicarinata" actually represents a specimen of *gadovii*.

Specimens examined: Guerrero: Omilteme and Chilpancingo (USNM 47737, 113173-113174; MCZ 42701-42715; EHT-HMS 23849-23876; CNHM 38516-38524). A total of fifty-six specimens. The form is not known from any other locality.

Barisia gadovii levigata, subsp. nov.

Plate II, figs. 3, 4, 5.

Type and type locality: Holotype: USNM 47212; an adult male from the "Valley of Oaxaca." Paratype: USNM 47855; an adult male from the "mountains west of Oaxaca City." Nelson and Goldman colls.

Range: Known only from the localities mentioned above.

Diagnosis: A *Barisia* of the *gadovii* group with a frontonasal; supranasals small, unexpanded; scales of the sides of the body

smooth, those of the back weakly keeled, and those of the neck smooth; two loreals and one (anterior) canthal, the latter separated from the anterior loreal by a contact of the posterior loreal with the upper postnasal; belly spotted with brown; dorsal color a light brownish gray.

Description of the holotype: No postrostral; nasal separated from the rostral by the anterior internasals. Supranasals small, unexpanded. Frontonasal in narrow contact with the frontal between the prefrontals. Two superposed postnasals. Two loreals and one (anterior) canthal, the latter narrowly separated from the anterior loreal by a contact of the posterior loreal with the upper postnasal. One preocular; one subocular; four postoculars, the lowest quite small. Superciliary series incomplete posteriorly, comprising four elements on the left, only two on the right—the three anterior being fused into a single long element; the most anterior superciliary is not in contact with the prefrontal. Five medial and three lateral supraoculars, the posterior lateral in contact with the orbit. Frontal touching the interparietal. Four primary and four secondary temporals, the uppermost primary in contact with the uppermost secondary, and the lowest primary in contact with only the lowest secondary. Four temporal elements in contact with the supralabials. Supralabials nine on the left, ten on the right; infralabials eight. Postmental paired, followed by three large and one much smaller chin shields on each side, of which the members of the first pair are in contact along the mid-ventral line. Four or five sublabials, the anterior extending to the first chin shield and second infralabial.

Dorsals in sixteen longitudinal and forty-seven transverse rows; ventrals in twelve longitudinal and fifty-one transverse rows. A minimum of eight scales in any single row across the nape. The lateral rows of dorsals are smooth, the median eight rows weakly keeled except on the neck, where all of the scales are smooth. All scales of the limbs and those of the sides of the tail smooth or very weakly keeled.

A light brownish gray dorsally, each individual scale finely mottled brown and gray. Sides with somewhat irregular blackish vertical bars, bordered posteriorly with white; about 10-12 such bars between the axilla and the groin, the more posterior ones indistinct. A dark line from the nasal through the lower part of the eye onto the lower temporal region, bordered below by a very prominent light stripe. Ventral surface a very light gray or yellowish,

with many brown spots which tend strongly to be arranged in longitudinal lines along the middles of the scale rows, particularly medially. Chin and infralabials with numerous irregular small brown dots, the infralabial region not banded.

Measurements of the holotype are as follows:

Snout-vent	107 mm.	Axilla-groin	55 mm.
Tail regenerated		Fore limb	24 mm.
Head length	24.4 mm.	Hind limb	30 mm.
Head width	16.8 mm.	Fourth finger	7.1 mm.
Head depth	13.5 mm.	Fourth toe	11.3 mm.

Description of the paratype: This specimen agrees with the holotype except as here noted.

Frontonasal separated from the frontal by the prefrontals. Three postoculars. Superciliary series complete, comprising three elements on the left, four on the right; four lateral supraoculars on the left, three on the right, none of which are in contact with the orbit. Probably nine supralabials on each side, but because of an injury this number is not entirely certain. Seven infralabials.

Transverse rows of dorsals forty-five; ventrals in fifty-two transverse series.

Somewhat lighter in color than the holotype; each dorsal scale primarily gray, very finely dotted with brown.

Measurements of the paratype are as follows:

Snout-vent	97 mm.	Axilla-groin	47 mm.
Tail	130 mm.	Fore limb	21 mm.
Head length	21.2 mm.	Hind limb	27 mm.
Head width	15.3 mm.	Fourth finger	6.0 mm.
Head depth	12.8 mm.	Fourth toe	9.7 mm.

Remarks: This form is closely related to *B. g. gadovii*, from which it differs chiefly in the separation of the anterior loreal from the anterior canthal, the much less extensive carination, and the lighter color, with brown rather than black ventral spots; probably also in the possession of a slightly lower number of transverse dorsal scale rows. The difference in coloration might conceivably be due to differences in manner of preservation, but this seems very unlikely in view of the large number of *g. gadovii* seen, comprising series from several different collections; included in these are Guerrero specimens collected by Nelson and Goldman, the collectors of the types of *levigata*.

The close general resemblance between this form and typical *gadovii* makes a subspecific relationship appear more probable than a specific one.

Specimens examined: Oaxaca: Valley of Oaxaca (USNM 47212, holotype); "Mountains west of Oaxaca City" (USNM 47855, paratype). No other specimens are known.

Barisia modesta (Cope)

Pterogasterus modestus Cope, 1877, Proc. Amer. Philos. Soc., 17:97.
Gerrhonotus modestus, Günther, 1885, Biol. Centr. Amer., Rept.: 42.

Type and type locality: USNM 7084 (three specimens). The type locality is uncertain. Cope states, "The precise locality from which the specimens of this lizard were sent to the Smithsonian Institution is uncertain, but is probably Guatemala." Dr. Hobart Smith informs me that the tags on these specimens bear the datum "Veracruz," and has stated (1942) that the "type locality [is] apparently Orizaba, not Guatemala as guessed by Cope."

Range: Uncertain; the form is known only from the types.

Diagnosis: A *Barisia* of the *gadovii* group with frontonasal; supranasals expanded; dorsal scales of the body and neck nearly smooth; two (?) loreals, no canthals (?); dorsal color "brown . . . the sides are a reddish brown or maroon . . ."

Description: I have not seen this form, and all descriptions to be found in the literature are derived from Cope's original description, which is copied below. The bracketed comments are mine.

"Scales 10/12 [a misprint for 16/12, *cf.* Smith, 1942] slightly convex above, but not keeled, excepting those of the tail, which are strongly and obtusely carinate or ribbed; an azygous scute [postrostral] between the two anterior pairs of internasals [anterior internasals and expanded supranasals]. Internasals of first pair reaching first labials. Internasals of third pair [posterior internasals] elongate, in contact with the frontonasals [prefrontals] behind, apparently including the small lateral interfrontonasals [anterior canthals?]. Two postnasals; a large plate, the anterior [posterior?] canthal, descends to the labials, from the inferior part of which a loreal may be separated. [I have not been able, from this description, to satisfy myself as to the exact arrangement of scales in this region.] Preoculars two or one. Two pairs of large infralabials [postmentals and anterior chin shields] in contact, following the symphyseal, without a single postmental; two pairs follow, of which the anterior are separated by one scute. Lateral fold extending from ear to vent; the granular area extending above the humerus. Appressed limbs separated by six cross-rows of abdominal scales, or the length of the fore arm. Rows of scales from nape to origin of tail, forty-seven; do. from humerus to vent, thirty-eight.

"The tail is not very long and is grooved below as well as above. Total length, .150 [presumably meters, hence 150 mm.]; length to

meatus auditorius, .012; to vent, .072; length of hind leg, .019. Color above, brown; below, olivaceous. The sides are a reddish-brown or maroon, bordered above by a blackish line which separates it from the dorsal color.

"This species differs from all others of the genus 'Pterogasterus' in the extinction of the small plate [anterior canthal] which truncates the lateral angle of the interfrontonasal [frontonasal]. As a consequence of this, the latter has a diamond shape, as it does not reach the frontal plate behind nor the azygous plate in front. The smooth scales also separate it from all others of the genus.

"The precise locality from which the specimens of this lizard were sent to the Smithsonian Institution is uncertain, but is probably Guatemala."

Remarks: The relationships of this form are at present obscure, but the presence of a paired postmental, a postrostral and frontonasal have induced me to place it tentatively with the *gadovii* group. The fact that Cope placed it in the genus *Pterogasterus,* in which he otherwise included only *Gerrhonotus liocephalus* and related forms, would argue a general similarity to *liocephalus;* such a general similarity is also observable in *B. gadovii.* A better knowledge of the scalation and information regarding the skeletal anatomy would be of great assistance in definitely allocating this form.

Specimens examined: None; since it is known only from the types, there are no definite locality records for this form. [At this time (1944) the types are not available for study at the National Museum.]

Barisia antauges Cope

Barissia antauges Cope, 1866, Proc. Acad. Nat. Sci. Philad., 1866:132.
Gerrhonotus antauges, Sumichrast, 1882, La Naturaleza, 6:40.

Type and type locality: USNM; collected by Professor Sumichrast, from Orizaba, Veracruz.

Range: Known only from the type locality.

Diagnosis: A *Barisia* of the *gadovii* group without a frontonasal; supranasals expanded; dorsal scales of the body and neck nearly smooth; two (?) loreals, no canthals; ventral surface very heavily mottled; dorsal surface "dark brown, with a subdivided iridescence as though greased."

Description: As in the case of *modesta,* very little is known concerning this form. I have not seen the type, and all literature descriptions subsequent to Cope's, but excepting the very brief characterization in Smith's (1942) key, have been written by authors who considered *B. viridiflava* a synonym of *antauges*; their descrip-

tions actually apply to the former species. Again the best procedure seems to be to copy Cope's description, and again the bracketed comments are mine.

"A species differing from those already known in the entire smoothness of the scales of the body, while those of the tail are arranged in obtuse and strong ridges. Nuchal rows eight, those of the body 16/12. A depression along the vertebral line; six scales margin the vent. Labials 10/8, three last superior nearly equal, separated by four rows of nearly equal temporals from the parietals. Latter as broad as long, well separated, with the frontoparietals, by the elongate interparietal. Five supraorbitals, embracing three superciliaries [lateral supraoculars]. Prefrontals longer than broad; three pairs supranasals [anterior internasals, expanded supranasals, posterior internasals]. Head short and elevated. End muzzle to axilla 1 in. 3 l. [approx. 32 mm.]; latter to vent 2 in. 1 l. [approx. 53 mm., the snout-vent length thus approximating 85 mm.]; from latter to end of tail 4 in. 1 l. [approx. 103 mm.; it is probable that the tail has been injured].

"Above dark brown, with a subdivided iridescence as though greased, and with many small blackish brown spots, which are more distinct on the tail. Sides with about seventeen irregular vertical black bars from opposite nape to groin, each bordered with yellow specks behind. Front of ear and lips black, yellow varied; body and tail below, blackish, with very many yellowish-white specks.

"No. 11, Sumichrast's Coll. Stated by Prof. S. to be very rare."

Smith offers the further information that this form possesses a paired postmental.

Remarks: As in the case of *modesta,* further information is necessary before any definite conclusions can be drawn. The consistent confusion of *viridiflava* with this form might lead one to expect a strong general similarity between the two, but, with the exception of Cope himself, probably none of the authors who considered the two synonymous had seen any specimens of *antauges.* Smith, who had seen the type, recognized the distinctness of *viridiflava.* The paired postmental indicates a probable affinity with the *gadovii* group; the size of the type specimen is also more consistent with this group than with the smaller *moreleti* or larger *imbricata* group.

So far as can be definitely determined, *antauges* and *modesta* differ chiefly in the presence or absence of a frontonasal and postrostal. If this be the case, and if *modesta* actually comes from Veracruz, there is a possibility that the two forms are identical.

Specimens examined: None; known only from Orizaba, Veracruz.

The *imbricata* group

Definition: *Barisia* with a paired postmental; nasal bones separated from each other by a broad contact between the frontal and premaxilla; pterygoid teeth vestigial; moderate to large forms, the maximum snout-vent length observed being 155 mm.; dorsal color brown, usually decidedly lighter than in other groups, and often without a dorsal longitudinal band; venter relatively light, sometimes suffused with gray, but not spotted or mottled over most of the surface; superciliary series incomplete posteriorly, sometimes anteriorly as well; no upper postnasal; usually a single (posterior) loreal, which may have a canthal split off dorsally (a small anterior loreal is also present in *rudicollis*); frontonasal and postrostral absent; lateral fold very well developed.

Range: Oaxaca and Veracruz northward to Chihuahua and Coahuila.

Discussion: In occasional specimens there is a partial fusion of the postmental elements, but this is rarely complete; the resulting scute is decidedly asymmetrical and obviously different from the symmetrical unpaired postmental of the *moreleti* group. The frontopremaxillary contact is broad, much broader than in *gadovii*. The pterygoid teeth are poorly developed and few in number, but close examination shows their constant presence; only occasionally do any protrude through the mucous lining of the roof of the mouth.

Although interspecific size differences are present, the average adult size of every form is greater than for any member of either of the other groups; the more northern forms are the largest. The dorsal color is a nearly uniform brown or tan in males of all forms excepting *rudicollis*. In that species, and in females of certain races of *imbricata*, a dorsal longitudinal band and lateral dark bars are present, much as in the other groups. The ventral surface tends to be uniformly light medially, but dark markings are frequently found laterally. There is never the heavy spotting or mottling of the belly frequently found in the other groups.

The superciliary series is without exception incomplete posteriorly (see discussion of this feature in connection with the *moreleti* group); often the anterior portion is also reduced or lacking, so that in some cases only a single element remains. Never does the series comprise more than four elements.

The upper postnasal is lacking, the supranasal and lower postnasal usually being in contact at the posterodorsal angle of the nasal. The supranasal is always present, never expanded. The

loreo-canthal group usually consists of a single large cantholoreal element, with occasionally a canthal split off from the dorsal portion; in *rudicollis* a small anterior loreal is also present. The frontonasal is normally lacking; rarely it occurs as a very small plate wedged between the posterior internasals and prefrontals. The postrostral is always absent.

The dorsal osteoderms are heavy and moderately rugose. They possess a strong, but usually obtuse, median keel and a strongly thickened basal portion. The lateral fold is well developed, containing a granular area more than equivalent to one lateral scale row in width. The side of the neck often contains a rather well-defined dermal pocket.

This group is the most highly modified of all Gerrhonotinae, with the possible exception of some *Abronia*. Among the more important specializations are included the consistent absence of the frontonasal, consistent strong reduction of the loreo-canthal group, reduction of the superciliary series, loss of the upper postnasal, and a broad fronto-premaxillary contact. Other specializations are shared with only a few other groups.

Barisia rudicollis (Wiegmann)

Plate I

Gerrhonotus rudicollis Wiegmann, 1828, Isis, 1828, no. 3:380.
Barisia rudicollis, Gray, 1838, Ann. Mag. Nat. Hist., ser. 1, 1:390.
Tropidogerrhonotus rudicollis, Fitzinger, 1843, Syst. Rept.: 21.
Barissia rudicollis, Gray, 1845, Cat. Spec. Liz. Coll. Br. Mus.: 55.

Type and type locality: Berlin Museum. Type locality given only as "Mexico," but is probably México (state).

Range: Except for the types the form is known only from a single specimen, first reported by Martín del Campo (1939), from the Hacienda La Gavia, in the state of México.

Diagnosis: A *Barisia* of the *imbricata* group with fourteen rows of ventrals; two loreals, no canthals; nasal in contact with the rostral; fewer than 33 transverse rows of dorsals; fourteen longitudinal rows of dorsals; anterior superciliary present, moderately large.

Description: Nasal in contact with the rostral below the anterior internasals. Two loreals, the anterior small, the posterior large, in contact with the prefrontal; no canthals. Postnasal in very narrow contact with the supranasal, or separated from it by a contact of the anterior loreal with the nasal, widely separated from the posterior internasal. Four superciliaries, the anterior separat-

ing the preocular from the first medial supraocular; the first superciliary large, its contact with the (posterior) loreal greater than that of the first medial supraocular with the loreal. Two or three suboculars; four postoculars. Four primary and four secondary temporals, the uppermost primary in contact with the uppermost secondary, the lowest primary with the two lower secondaries and with the penultimate and antepenultimate supralabials. Supralabials 10-12; infralabials 8-9. Postmental paired, followed by three large and one or two smaller pairs of chin shields, of which the members of the first pair are in contact along the mid-ventral line. The sublabials extend anteriorly to the first chin shields and second infralabials.

Dorsals in fourteen longitudinal and about 27-29 transverse rows; ventrals in fourteen longitudinal and about forty-seven transverse series. All but the lateral rows of dorsals are at least lightly keeled, the median eight rows very prominently so. The occipital, interparietal and upper temporals are also keeled. Six longitudinal rows of scales across the nape, all strongly keeled.

Dorsum a grayish brown; sides with prominent but very irregular vertical black bars bordered posteriorly with white; these white markings are continued across the back as very indistinct light bands. Dorsum of head brownish flecked with white, lighter laterally, the labial and lower temporal regions cream colored. Rostral and each of the anterior supralabials with a narrow black stripe along their posterior borders. A black stripe across the preoculars and suboculars to the antepenultimate supralabial, at the anterior border of which it bends down sharply to the lip. Venter whitish with irregular, prominent black markings laterally.

Measurements of the single example seen are:

Snout-vent	105 mm.	Axilla-groin	51 mm.
Tail—tip broken off		Fore limb	28 mm.
Head length	25.4 mm.	Hind limb	34 mm.
Head width	18.5 mm.	Fourth finger	8.3 mm.
Head depth	14.2 mm.	Fourth toe	11.4 mm.

Remarks: Although certainly a member of the *imbricata* group, this form differs widely from all others in the group. It is probably an early, but in some respects highly specialized, derivative of the ancestral stock of this group. The fourteen rows of ventrals, two loreals, four superciliaries and extensive carination are regarded as primitive features indicating an early derivation. The low number of transverse dorsal scale rows, the naso-rostral contact, and distinctive color pattern are thought to be modifications peculiar to this form.

Nothing is known concerning the habitat of this form, but there are some indications that it may be arboreal—in contrast to all other members of the genus. The lichen-like color pattern is strongly suggestive of arboreal habits. The limbs are relatively long; only this form of all the *Gerrhonotus-Barisia-Elgaria* complex is comparable to the arboreal *Abronia* in relative limb length. The fact that a form with such a large number of primitive features would continue to exist so near the generic center of dispersal might be taken as an indication that this form occupies a different habitat than its more highly modified relatives. Even the rarity of specimens in museum collections lends credibility to the hypothesis that it is arboreal. This same paucity has been characteristic of all members of the genus *Abronia* until very recently, that is, until it was discovered that they are primarily tree-dwelling forms.

Specimens examined: México (state): Hacienda de la Gavia (IBM, one specimen). No other specimens with definite locality data are known.

Barisia imbricata imbricata (Wiegmann)

Gerrhonotus imbricatus Wiegmann, 1828, Isis, 1828, no. 3: 381.

Gerrhonotus lichenigerus Wagler, 1830, Icon. Amph.: Fasc. II, pl. 24, fig. 2. (Type locality: México.)

Gerrhonotus adspersus Wiegmann, 1834, Herp. Mex.: pl. 10. (Type locality: Mexico [by inference].)

Barisia imbricata, Gray, 1838, Ann. Mag. Nat. Hist., ser. 1, 1: 390.

Barisia lichenigerus, Gray, 1838, *ibid.*: 390.

Barissia imbricata, Gray, 1845, Cat. Spec. Liz. Coll. Br. Mus.: 55.

Barissia lichenigera, Gray, 1845, *ibid.*: 55.

Gerrhonotus olivaceous Baird, 1859, Proc. Acad. Nat. Sci. Philad. for 1858: 255. (Type locality: México [erroneously stated by Baird as "near San Diego, Calif."]

Barissia olivacea, Cope, 1875, Bull. U. S. Nat. Mus., 1: 46.

Gerrhonotus [*imbricatus*] *imbricatus*, Dunn, 1936, Proc. Acad. Nat. Sci. Philad., 88: 475.

Gerrhonotus imbricatus adspersus, Smith, 1942, Proc. U. S. Nat. Mus., 92, no. 3153: 368.

Type and type locality: Berlin Museum, the type locality is given only as "Mexico."

Range: Central México (state), the Distrito Federal and Morelos, westward into Michoacán, eastward to Veracruz and southward to central Oaxaca; northward into southern Hidalgo and probably southern Guanajuato.

Diagnosis: A *Barisia* of the *imbricata* group with twelve rows of ventrals; one loreal and no (occasionally one) canthals; nasal usually separated from the rostral by the anterior internasals; 34-42 transverse and usually 14, sometimes 12, longitudinal rows of dorsals; dorsal color light brown, females with darker brown cross bands, or lateral bands plus mid-dorsal blotches; coloration of venter variable; first superciliary present, moderate in size, usually separating the preocular from the first medial supraocular; lowest

primary temporal in contact with the penultimate and antepenultimate supralabials.

Description: Nasal normally separated from the rostral by the anterior internasals. One loreal, in contact with the prefrontal, rarely with a canthal split off dorsally. Postnasal in rather broad contact with the supranasal, widely separated from the posterior internasal. Generally three supereiliaries, the anterior usually separating the preocular from the first medial supraocular; the anterior supereiliary is of moderate to small size, its contact (if any) with the loreal usually shorter than the contact of the first medial supraocular with the loreal. Two or three suboculars; three, rarely four, postoculars. Four primary and four secondary temporals, the uppermost primary in contact with the uppermost secondary, the lowest primary in contact with the two lowest secondaries and with the penultimate and antepenultimate supralabials. Supralabials 9-11, usually ten; infralabials 6-9. Postmental paired, followed by three large pairs and one smaller pair of chin shields, of which the members of the first pair are in contact along the mid-ventral line. The sublabials extend anteriorly to the first chin shields and second infralabials, occasionally to the postmental.

Dorsals in fourteen longitudinal rows, frequently only twelve in specimens from the Distrito Federal and westward; 34-42 (ave. 39.3) transverse rows. Ventrals in twelve longitudinal and 50-58 (ave. 55.1) transverse series. Caudal whorls 91-108 (ave. 100.5). The median six or eight rows of dorsals strongly keeled, with one or two lateral rows more weakly keeled.

Tan to brown above, males nearly uniform or with a few small scattered white spots. Females with dark brown vertical bars on the sides, sometimes bordered posteriorly with white; a corresponding series of mid-dorsal dark blotches, frequently expanded into bars more or less confluent with those of the sides. Ventral color yellowish to dark gray, darker laterally than medially. There is no mottling or prominent spotting, but in a few specimens there is a tendency for the dark color to form transverse lines between the scale rows. Infralabials and sublabials usually rather dark, but chin shields usually light excepting in specimens from Veracruz and northern Puebla. Females from the western part of the range may have a color pattern similar to that of the male, with the dark bars very indistinct or lacking.

These are moderately large lizards, adults averaging about 110 mm. in snout-vent length, the maximum observed being 126 mm.

Tail about 1.35-1.50 times the snout-vent length, slightly longer in the younger specimens than in the older ones.

Remarks: The species *imbricata* is well defined and readily distinguishable from both *rudicollis* and *levicollis*, though more closely related to the latter. Probably the most convenient character is the number of transverse dorsal scale rows, 34-45 in *imbricata*, below 33 in *rudicollis*, and above 45 (with a single known exception) in *levicollis*. Geographic races within the species are, however, not so easily determined; only one such race (*i. ciliaris*) is really well defined. In the case of variants found near the periphery of the known range, especially where the boundary of the known range probably represents a boundary of an area worked by collectors rather than a boundary of the true range of the animal, the question of whether or not truly subspecific populations are represented by the known specimens cannot be definitely answered at present. Specific cases of this sort will be mentioned subsequently.

The majority of known specimens of *i. imbricata* are from the vicinity of the Distrito Federal, but I do not believe these are entirely typical of the subspecies. The typical populations inhabit eastern México and Morelos, southern Puebla, and northern Oaxaca. These specimens all have fourteen dorsal scale rows, uniformly light chin shields, no canthal, and an anterior superciliary which, while not large, separates the preocular from the first medial supraocular.

Specimens from western México and Michoacán represent a peripheral population of the type mentioned above. For this population Dr. Hobart M. Smith recently (1942) revived the name of *adspersa* Wiegmann, 1834. With his permission, I offer the following comments, taken from his unpublished notes, which he has kindly allowed me to make use of: "*G. adspersus* generally has been considered a synonym of *imbricatus*. It appears that Wiegmann was at the point of describing it when Wagler published the description of *lichenigerus*. Wiegmann concluded that his *adspersus* was a synonym of *lichenigerus*, and so treated it in his Herpetologia Mexicana (1834). However, a figure of the head plates of *adspersus* was published, under that name, in the latter work. The figure shows that the nasal is broadly in contact with the rostral, a condition which very rarely occurs in *imbricatus*. Wiegmann's description of *lichenigerus*, probably based solely upon his type of *adspersus*, states that the longitudinal series of dorsals number 12." Smith had available a single specimen from western México (state); this specimen has twelve dorsal scale rows and the nasal in contact with the rostral, agreeing in these respects with *adspersa*, and in

view of the extremely small probability of finding these two characteristics together on the basis of pure chance, concluded that a western subspecies exists to which the name *adspersa* is applicable. I have since had the opportunity to examine one more specimen from western México and three from Michoacán, making a total of five specimens from the presumed range of this questionable form. Of these, two possessed a full fourteen scale rows; only the one showed a naso-rostral contact (a condition seen on only one side of one individual from any other part of the range of *imbricata*), although in another the separation was decidedly narrower than usual; three of the five had a canthal split off from the loreal on at least one side—another condition rarely found in specimens from the central part of the range and also exhibited in Wiegmann's figure of *adspersa*. In one female specimen the transverse bands are indistinct, in the other (three are males) these bands are indiscernible, indicating a possibility of a lesser sexual dimorphism in color pattern than in the typical population. The occurrence of all these variants certainly shows that this western population is atypical, but, on the basis of the few specimens available, none show a high enough percentage of occurrence to allow definition of a recognizable subspecies in this area; it may simply be a case of "peripheral variation." I therefore consider it best for the present to continue to consider *adspersa* as a synonym of *imbricata*. By this I do not imply that I do not believe it quite possible that a recognizable subspecies is represented, but that present specimens are insufficient to demonstrate the existence of such a subspecies, or to provide a diagnosis. If further collection shows that this population is demonstrably subspecifically distinct, the name *adspersa* would probably be correctly applied to it. It should be mentioned here that a relatively large number of specimens from the Distrito Federal and vicinity have only twelve dorsal scale rows, and might in this respect be thought of as "intergrades."

A series from Cruz Blanco, Veracruz, has the preocular and first medial supraocular in contact in about 60% of the specimens, and the chin shields are gray or marked with gray in all adults. Specimens from Orizaba and Acultzingo to the south and Teziutlan, Puebla, to the northwest, exhibit these same features to a lesser degree. Although this geographic variant is well marked, I do not believe that the proposal of a new subspecific name is warranted, terming, as would be necessary if such a course were followed, the Acultzingo-Orizaba and Teziutlan populations as intergrades between the Cruz Blanco and typical forms.

Specimens examined: Distrito Federal: Near Ajusco (AMNH 15486); Chiribusco (MCZ 28377); near Guadelupe (AMNH 15483); near México (city) (EHT-HMS 10406); near San Juanico (AMNH 15484-15485); San Juan Teotihuacan (MCZ 6345, 4 spec.).

México: Desierto de los Leones (EHT-HMS 10398-10401); Lake Lerma (EHT-HMS 19144-19145); Llano Grande (EHT-HMS 23838-23840, USNM 113213); Nevado de Toluca (EHT-HMS 22218-22219, 23808-23809, 23836-23837; USNM 113219); San Martín (EHT 10396); Villa Victoria (USNM 113215); Zempoala (USNM 113209-113212).

México or *Morelos:* Lake Zempoala (EHT 10402-10404; 10426, 19133-19136); Monte Río Frío, 45 km. ESE of México (city) (TAM 711, 738-743); 55 km. SE of México (city) (TAM 911-918); 45 km. SW of México (city) (TAM 919-920).

Michoacán: Mount Tancítaro (USNM 47787, UMMZ 94411); 10 km. Northwest of Zacapu (UMMZ 94412).

Morelos: Tepoztlan (EHT-HMS 28870); near Tres Marias (EHT-HMS 10422).

Puebla: Cacoloapam (EHT-HMS 10397); Teziutlan (EHT-HMS 23841-23846); Popocatepetl (EHT-HMS 19137, 23807); Río Otlati, 15 km. NW of San Martín (TAM 901).

Veracruz: Acultzingo (USNM 113204-113208, EHT-HMS 28871-28878); Cruz Blanco (EHT-HMS 10405, 10407-10417, 10423-10425, 10427); Orizaba (EHT-HMS 19138-19139, USNM 7087, 2 spec., 19262, 47774); 4 km. S of Jalacingo (Univ. of Kansas, uncatalogued).

Hidalgo: El Chico National Park (EHT-HMS 19141); San Miguel (MCZ 11434); Tianguistengo (EHT 23848); Zacualtipan (EHT-HMS 19142, 23847).

Oaxaca: Reyes (USNM 47392); Zempoaltepec (?) (47189-47191).

Indefinite or extremely doubtful localities: USNM 3088, 7036, 8317, 26165, 32166; AMNH 19304, 24760-24763.

A total of 128 specimens. The form is also reported from Palambá, Michoacán; Cuernevaca, Morelos; and Nevado de Colima, Jalisco, the last not certainly referable to this form.

Barisia imbricata ciliaris (Smith)

Gerrhonotus levicollis ciliaris Smith, 1942, Proc. U. S. N. M., 92, no. 3153: 365.

Type and type locality: USNM 47496; from Sierra Guadelupe, Coahuila.

Range: Hidalgo and Guanajuato northward to Chihuahua and Coahuila.

Diagnosis: A *Barisia* of the *imbricata* group with twelve rows of ventrals; one loreal, usually no canthal; nasal separated from the rostral; about 39-45 transverse and usually sixteen longitudinal rows of dorsals; dorsal color a nearly uniform light brown above in both sexes, often spotted with white; venter light; first superciliary moderate or large, separating the preocular and first medial supraocular; lowest primary temporal in contact with the penultimate and antepenultimate supralabials.

Description: Nasal separated from the rostral by the internasals. One loreal; normally no canthals; postnasal in rather broad contact with the supranasal. Three superciliries, the anterior normally separating the preocular from the first medial supraocular; first superciliary moderately large, its contact with the loreal usually about equal to the contact of the first medial supraocular with the loreal. Two suboculars; three postoculars. Four primary and four secondary temporals, the uppermost primary in contact with the uppermost secondary, the lowest primary in contact with the

two lowest secondaries and with the penultimate and antepenultimate supralabials. Supralabials 9-11; infralabials 8-10. Postmental paired, followed by three large pairs and one smaller pair of chin shields, of which the members of the first pair, occasionally also the second, are in contact along the mid-ventral line. The sublabials usually extend anteriorly to the first chin shields and second infralabials, frequently to the postmental, less commonly to the first infralabial.

Dorsals usually in sixteen longitudinal and 39-45 (ave. 41.3) transverse rows; Smith records a single specimen with 49 transverse rows, but I have seen none with more than 45. Ventrals in twelve, occasionally fourteen, longitudinal and 53-61 (ave. 57.8) transverse rows. Caudal whorls 87-102. The median six or eight rows of dorsals are keeled.

A nearly uniform light brown above, often with a reddish or yellowish cast; small scattered white spots often present. Venter uniformly light except laterally, where it may be slightly darkened.

These are large lizards, adults averaging about 120 mm. in snout-vent length; the maximum observed is 145 mm. Tail about 1.30-1.60 times the snout-vent length.

Remarks: This form is distinguished from *i. imbricata* by the larger number of dorsal scale rows, both transverse and longitudinal, by the color pattern (particularly that of the female), and to a lesser extent by the larger first superciliary. This is also a definitely larger race.

A female specimen from Atotonilco Grande, Hidalgo resembles *i. imbricata* in scalation, but has the uniform color of *ciliaris*. Other southern Hidalgo specimens resemble *i. imbricatus* in all respects, while a specimen from northern Hidalgo is typical of *ciliaris*. A subspecific relationship between the two forms, with intergradation occurring in central Hidalgo, appears probable.

A female specimen (LSU R28) has an unpaired postmental; four of ten embryos contained in the uteri have this same rare condition.

Specimens examined: Durango: Inde (USNM 46843).

Guanajuato: San Felipe (EHT-HMS 10418-10421).

Hidalgo: Durango (EHT-HMS 23803). *ciliaris* x *imbricata*, Atotonilco Grande (EHT-HMS 19140).

Nuevo León: Pablillo, Galeana (EHT-HMS 19131).

San Luis Potosí: No further data (MCZ 4547, 8339); near Jesus Maria (USNM 47207-47210); between Llano de Conejo and Llano de Garzas, 7,000 ft. (R28 Louisiana State Univ.).

Sinaloa: Esquinapa (AMNH 585).

A total of sixteen specimens. Other locality records are: Sierra Guadelupe, Coahuila; Coyotes, Durango; Sierra de Santa Rosa, Guanajuato; Sierra Madre, Zacatecas.

Barisia imbricata planifrons (Bocourt)

Gerrhonotus (*Barissia*) *planifrons* Bocourt, 1879, Miss. Sci. Mex., Rept., livr. 6: 361.
Gerrhonotus planifrons, Günther, 1885, Biol. Centr. Am., Rept.: 38.
Barissia planifrons, Cope, 1887, Proc. Amer. Philos. Soc., 17: 97.

Type and type locality: A presumably young specimen in the Paris Museum; the type locality is given only as "Oaxaca."

Range: Uncertain, but probably southern Oaxaca; typical *i. imbricata* is known from Reyes, and two specimens from Cerro San Felipe are thought to be *imbricata* × *planifrons* intergrades.

Diagnosis. A *Barisia* of the *imbricata* group with twelve rows of ventrals; one loreal and usually no canthal; nasal separated from the rostral; about 35-39 transverse and sixteen longitudinal rows of dorsals; coloration as in *i. imbricata;* first superciliary relatively large, separating the preocular and first medial supraocular; lowest primary temporal in contact with only the antepenultimate supralabial.

Description: The following description applies to the type specimen, as described and figured by Bocourt.

Nasal separated from the rostral by the anterior internasals. One loreal; no canthal; postnasal slightly separated from the supranasal by a naso-loreal contact. Three superciliaries, the anterior separating the preocular and first medial supraocular; it is of large size, its contact with the loreal greater than the contact of the first medial supraocular with the loreal. Two suboculars; three postoculars. Four primary and four secondary temporals, the uppermost primary in contact with the uppermost secondary, the lowest primary in contact with the two lowest secondaries and with the antepenultimate, but not the penultimate, supralabial. Supralabials ten; infralabials eight or nine. Postmental paired, followed by three large pairs and one smaller pair of chin shields, of which the members of the first pair are in contact along the mid-ventral line.

Dorsals in sixteen longitudinal and about thirty-five transverse rows; ventrals in twelve longitudinal rows. The median eight rows of dorsals are strongly keeled.

Color pattern apparently similar to that of *B. i. imbricata.*

Remarks: Two specimens from Cerro San Felipe, Oaxaca, agree with the above description except as follows: One specimen has a canthal split from the dorsal portion of the loreal on one side; supranasal and postnasal in contact in both; in one the lowest primary temporal is in contact with the penultimate supralabial; dorsals in sixteen longitudinal rows in one, fourteen to fifteen in the other; ventrals in 53 and 54 transverse rows.

Though these specimens are not entirely typical of *planifrons* as described above, they do resemble the type specimen of that form in certain features. I have therefore tentatively assigned them to the category of *imbricata* × *planifrons*, assuming that a population to which the name *planifrons* is applicable actually exists somewhere south of Cerro San Felipe.

In many respects this form resembles *ciliaris* more closely than it does typical *imbricata*, but differs in the lower number of transverse dorsal scale rows and in the fact that the lowest primary temporal is not in contact with the penultimate supralabial, probably also in color pattern.

Specimens examined: Oaxaca: Cerro San Felipe, *planifrons* x *imbricata* intergrades (EHT-HMS 19132, 19143). No other specimens known with definite locality data.

Barisia levicollis Stejneger

Barissia levicollis Stejneger, 1890, Proc. U. S. Nat. Mus., 13, no. 809: 184.
Gerrhonotus imbricatus levicollis, Dunn, 1936, Proc. Acad. Nat. Sci. Philad., 88: 475.
Gerrhonotus levicollis levicollis, Smith, 1942, Proc. U. S. Nat. Mus., 92, no. 3153: 368.

Type and type locality: USNM 9362; said to be from the "Mexican boundary," probably from central Chihuahua.

Range: Known only from central and southern Chihuahua.

Diagnosis: A *Barisia* of the *imbricata* group with twelve rows of ventrals; one loreal and no canthal; nasal separated from the rostral; forty-six or more transverse and sixteen longitudinal rows of dorsals; uniform light brown above, with or without small scattered white spots; venter light, often with black spots laterally; a single (middle) superciliary, the preocular in contact with the first medial supraocular; lowest primary temporal usually in contact with only the antepenultimate supralabial.

Description: Nasals separated from the rostral by the anterior internasals. One loreal, often separated from the prefrontal by a contact of the first medial supraocular with the posterior internasal; no canthals. Postnasal in rather broad contact with the supranasal, usually also with the posterior internasal. Only a single superciliary present, corresponding to the most posterior element of this series in *imbricata;* the preocular therefore in contact with the first medial supraocular, and usually also with the first lateral supraocular. Two suboculars; two postoculars, the upper quite large, the lower very small. Four primary and four secondary temporals, the uppermost primary in contact with the uppermost secondary, the lowest primary in contact with the two lowest secondaries and with the antepenultimate but not the penultimate supralabial. Supralabials 9-11; infralabials 6-9. Postmental paired, followed by three

large pairs and one smaller pair of chin shields, of which the members of the first pair are in contact along the mid-ventral line. The sublabials extend anteriorly to the first chin shields, occasionally the postmental, and the second infralabials.

Dorsals in sixteen longitudinal and 45-51 (ave. 47.8) transverse series; ventrals in twelve longitudinal and 57-64 (ave. 61.0) transverse rows. Caudal whorls 99 and 102 in two specimens with undamaged tails. The median six or eight rows of dorsals are keeled, but not so strongly as in *imbricata*.

Both sexes a uniform tan above, occasionally with small scattered white spots. Venter nearly uniform yellowish or light gray, usually with small blackish spots laterally.

This is the largest form of the genus, adults averaging about 125 mm. in snout-vent length; the observed maximum 157 mm. Tail about 1.4 times the snout-vent length.

Remarks: Despite the fact that in certain respects *ciliaris* is intermediate between *i. imbricata* and *levicollis*, the latter is possessed of so many unique characters that I have chosen, pending further information, to consider it specifically distinct. The range of *levicollis* within Chihuahua is not known, since most of the specimens bear incomplete locality data, but it certainly extends as far south as Batopilas. All of the specimens I have seen are typical *levicollis*, with no tendency towards *ciliaris*. A single specimen of *ciliaris* with the only locality data being "Chihuahua" is completely typical of that form. Thus while there is no positive evidence of any overlap in the ranges of these two forms, there is at least some indication that such an overlap may occur. The Chihuahua-Durango border region would appear to be the critical area for the solution of this problem.

Specimens examined: Chihuahua: No further data (AMNH 1945, USNM 26603); "north Chihuahua" (AMNH 592-594); Colonia Garcia (MCZ 6977); Meadow Valley (USNM 26602, 26612); 65 miles east of Batopilas (USNM 47413).

A total of nine specimens. Also reported from Samachique, Chihuahua.

GENERAL REMARKS

I have previously (American Midland Naturalist) pointed out that the *Barisia-Gerrhonotus-Elgaria* ancestral stock probably inhabited the northern Mexican plateau region in the lower Oligocene, and postulated possession by this stock of the following characteristics: Skull similar to that of *Elgaria;* dorsal osteoderms as in *Barisia;* cephalic scutellation much as in *Gerrhonotus l. infernalis;* body scales moderately numerous, extensively carinated, much as in *Barisia moreleti;* general color pattern similar to that of *Barisia moreleti* and *Elgaria c. coerulea, i. e.,* a longitudinal light band dorsally and black white-tipped scales laterally, irregularly arranged; belly rather strongly mottled; postero-ventral surfaces of forearms and shanks nearly agranular; tail moderate in length.

One section of this stock became modified at the center of dispersal; the pterygoid teeth were reduced, there was some reduction of the loreo-canthal group of head plates, and the posteroventral surfaces of the forearms and shanks became more granular. These and other minor modifications produced a "*Barisia* prototype" stock in this central area. Continued modification in and southward migration from this area produced the present arrangement of forms within the genus *Barisia,* as discussed in the subsequent paragraphs. There was no northward migration of *Barisia* from this region, but the establishment of a proto-*Elgaria* stock in the Chihuahua-Sonora region is probably an integral part of the same general outward movement as the southward migration of the early *Barisia.*

As indicated, the *Barisia* prototype was similar in many respects to *B. m. moreleti,* but with certain important exceptions. The pterygoid teeth, though probably in the process of reduction, had not been completely lost; the internasal, frontonasal, and prefrontal elements were all moderately developed; a postrostral was present, at least in a certain proportion of this stock.

Certain specializations appeared in the population near the center of dispersal, while forms retaining the more primitive characters migrated southward. The first migrant group crossed the Isthmus of Tehuantepec, becoming established south of that barrier, but the movement did not proceed beyond northern Central America at that time; this may have been due to an inability to overcome the barrier constituted by the southern Nicaragua lowlands. That area was submerged in the early and middle Miocene, but complete submergence was probably not necessary to form an effective barrier.

The single postmental, characteristic of the *moreleti* group, was probably developed during the period of southward movement, since

it is found in *viridiflava*. This species is thought to have originated from a portion of the group which survived north of the Isthmus, rather than one which re-entered the area from the south. The only specialized group characters in which it agrees with the southern members are the complete lack of pterygoid teeth and the possession of an unpaired postmental. The usual absence of a frontonasal and the frequent occurrence of a postrostral indicate that separation from the remainder of the group took place before the modifications affecting these elements in the rest of the group occurred. Moreover, a large number of modifications are found in *viridiflava* but not in the more southern members of the group; this might also be taken as evidence for a long period of isolation of this species.

The Guatemala-Nicaragua section developed an enlarged frontonasal and lost the postrostral; these modifications are common to all races of *moreleti* (and also to *monticola*). In different parts of the range the minor modifications appeared which differentiate the existing subspecies of *moreleti,* as have been mentioned in the text.

The entrance of members of this group into southern Central America was subsequent to the establishment of the species *moreleti* in the north, rather than an integral part of the original southward movement. All of the specializations common to all races of *moreleti* are also to be found here, in addition to those others which have appeared subsequent to separation from the northern group. These latter include particularly a modification of the color pattern and a reduction of the number of longitudinal dorsal scale rows. The number of transverse dorsal rows is also somewhat reduced, and the supranasal has been lost in a large proportion of the population.

The second group moving southward from the dispersal center differed in a number of respects from the first. Here again the pterygoid teeth were completely lost, but the postmental in this case remained paired. The color pattern was slightly modified, the dark, usually white-tipped, scales of the sides being arranged into definite, more or less regular, vertical bars, which were sometimes continued across the back. A fronto-premaxillary contact developed in the skull; the number of longitudinal dorsal scale rows was reduced to sixteen, and the general size increased slightly. All of these modifications, with the exception of the complete loss of the pterygoid teeth, must have occurred in the original center of dispersal, rather than during the course of migration, since they are shared by this group and the succeeding one which originated from that center.

This second migrant group, the prototype of the *gadovii* group, pushed southward to the Isthmus of Tehuantepec but failed to cross

that barrier. It has since been obliterated everywhere except for a small area in southern Guerrero and northern Oaxaca, and another limited area in Veracruz. The Guerrero form, *B. g. gadovii,* is thought to resemble very closely the original migrant population, although there is a loss of certain elements, such as the postrostral, from a large percentage of the population. The Oaxacan *g. levigata* shows only minor modifications of coloration and scalation. The Veracruz group reduced the number of loreo-canthal elements, expanded the supranasals, and in the case of *antauges* presumably lost the frontonasal.

The population remaining at the center of dispersal, in contrast to these two major migrant groups, retained pterygoid teeth in a vestigial condition. Numerous modifications in scalation appeared, in addition to those shared with the *gadovii* group. The posterior superciliaries, frontonasal, upper postnasal and postrostral were all lost. The granular area of the lateral fold was decidedly enlarged. The entire color pattern was greatly lightened. The loreo-canthal group was reduced to probably two loreals and a single (posterior) canthal on each side. There was also a general increase in size.

A portion of this population became somehow isolated at a relatively early date, yet without being geographically far removed from the center of dispersal. This particular form, *rudicollis,* became highly specialized in several respects, *e. g.,* the great reduction in number of transverse dorsal scale rows, but the retention of the anterior loreal and of four superciliaries indicate that it is an earlier derivative of the *imbricata* stock than are other existing members of the group. The early distribution of this form may have been somewhat different than at present, but evidence has been presented that its early isolation may have been ecological rather than geographical.

In the central population the number of superciliaries was reduced to three and the anterior loreal lost. Some such form as this spread over most of México south to, or nearly to, the Isthmus of Tehuantepec. In the central to southern part of that range the anterior superciliary was somewhat reduced and the number of dorsal scale rows reduced to fourteen. These two features spread throughout most of the region south of 21 degrees latitude, except for a small area in Oaxaca where *planifrons* presumably occurs. In the western part of that area the number of dorsal scale rows has been further reduced to twelve in a sizable percentage of the population, and the anterior canthal perhaps retained in a relatively large proportion. Throughout the remainder of the range, including the area north of 21 degrees, the canthal was lost in the majority of the population.

Roughly north of 21 degrees these changes did not occur, except that in *ciliaris* the number of transverse rows of dorsals may have decreased slightly. The northern forms are definitely larger than the southern, probably larger than the early widespread population. In addition, the dark transverse bars have been lost in both sexes.

In Chihuahua the high number of transverse dorsal rows was retained. As in all the northern group, the dark bars were lost in both sexes and the size presumably increased. Other modifications have occurred here, the most obvious being the reduction of the superciliary series to a single element. Others include the usual contact of the posterior internasals with the postnasals, and often also with the first medial supraoculars.

Although all forms of this genus are found only at relatively high altitudes, it appears that members of the *moreleti* group regularly occupy somewhat higher altitudes, on the average, than do members of either of the other groups. Certain characteristics of that group should be pointed out as probable correlatives of that fact. Firstly, the individuals in this group are decidedly smaller than are representatives of the other two groups. Secondly, this group is more heavily and darkly pigmented than the other groups, the difference from the *gadovii* group, however, being much less pronounced than that from the *imbricata* group. This dark coloration and small size are frequent characteristics of poikilothermous forms found at high altitudes (or northern latitudes), the presumption being that these features allow more efficient utilization of radiant heat from the sun, the dark pigment increasing the absorptive capacity of the surface and the small size producing a greater surface area relative to the mass of the body. Thirdly, it seems probable that the *moreleti* group is ovoviviparous, the other groups may or may not be. I know of no direct observations on this point for any of the forms concerned, but eggs have been observed in the uterus of female specimens of the *moreleti* group with embryos up to 26 mm. in length; it is therefore obvious that considerable development takes place while the egg remains in the uterus, and it is probable that the young are born alive. In the other two groups, well-developed embryos were found only in *B. i. ciliaris;* fully matured eggs were frequently found in other forms, but no recognizable embryos were ever observed. In both *gadovii* and *i. imbricata* a series of specimens taken at the same time (approximately) contained females with mature eggs and one or more females in which the uterus was empty and had a deflated appearance, indicating that oviposition had recently occurred. This would indicate an oviparous habit for these forms.

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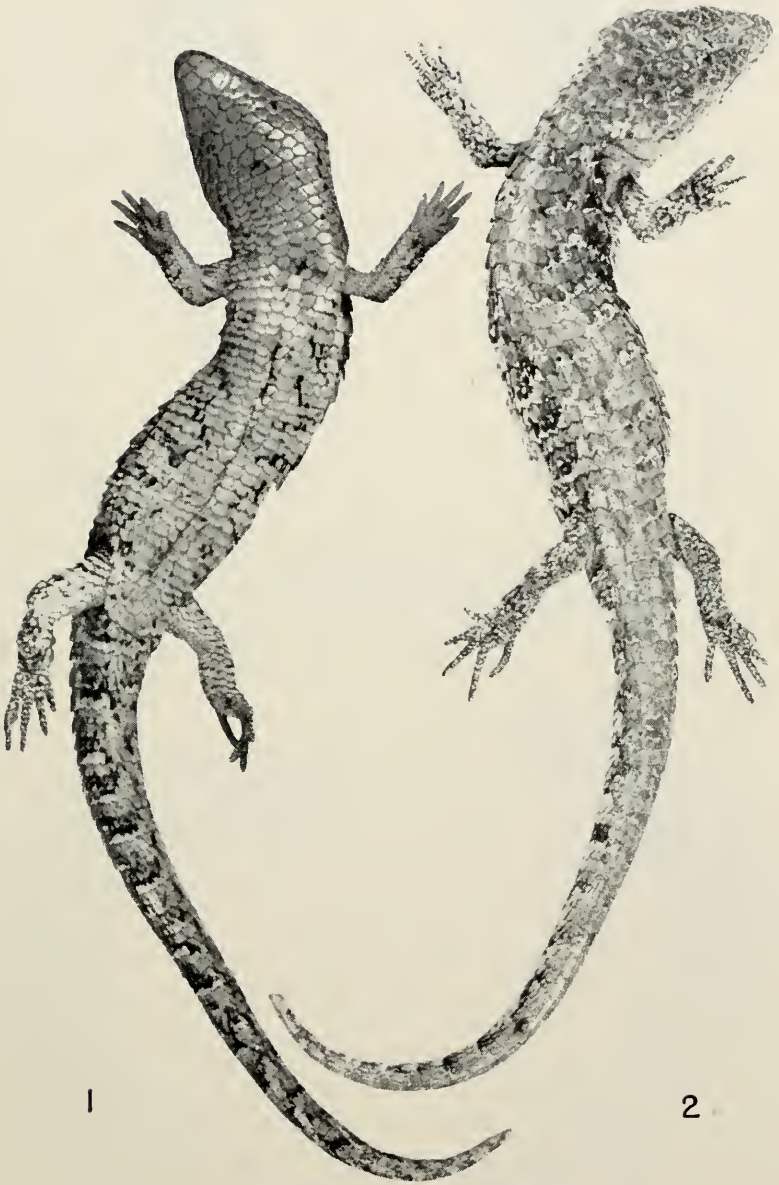

PLATE I. *Barisia rudicollis.* Specimen in Instituto de Biología de México. Hacienda de la Gavia, México (state) México. Actual snout-to-vent length, 105 mm.

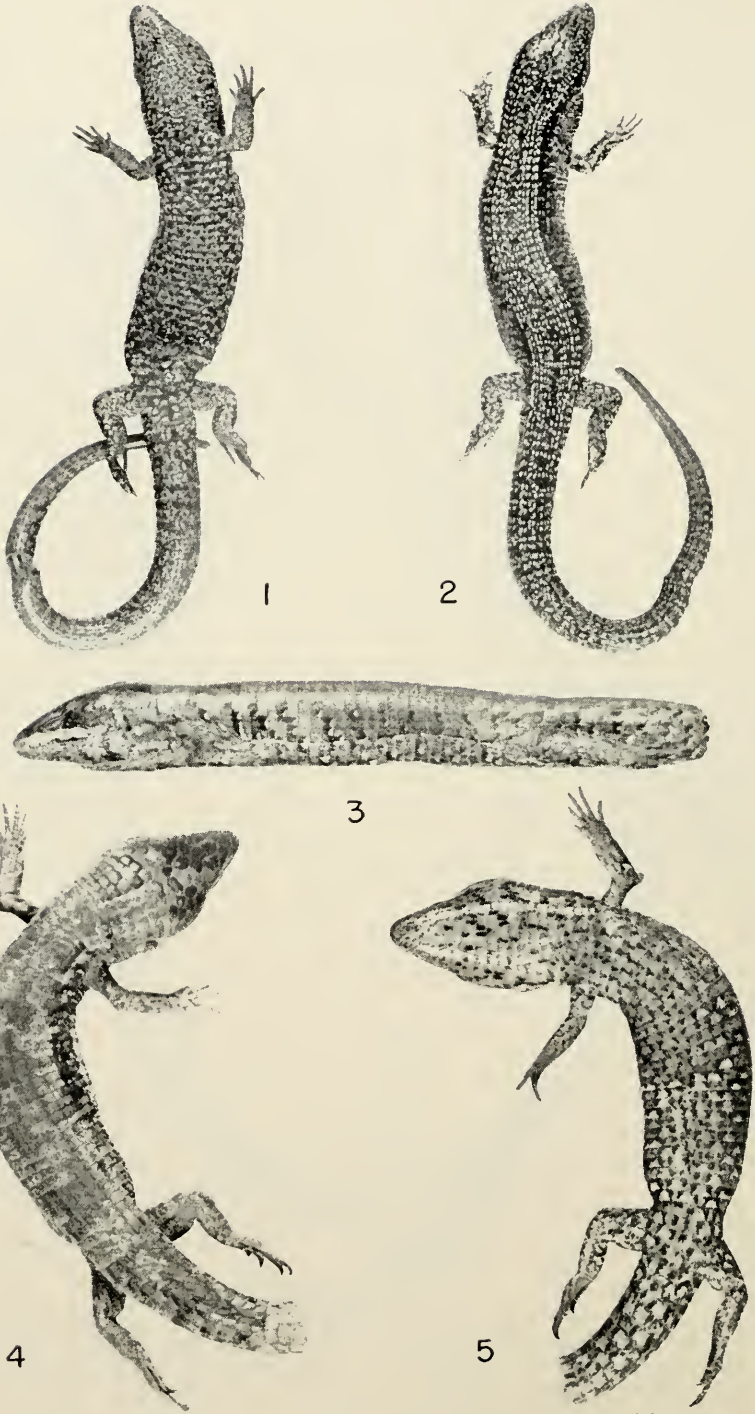

PLATE II. Figures 1 and 2. Ventral and dorsal views of *Barisia monticola*. Museum of Comparative Zoölogy, Harvard College no. 15467; Volcán Poas, Costa Rica. Actual snout-to-vent length, 75 mm. Figures 3, 4, and 5, *Barisia gadovii levigata*. Holotype U. S. National Museum no. 47212; "Valley of Oaxaca" México.

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Costa Rican Frogs of the Genera *Centrolene* and *Centrolenella*

BY

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ABSTRACT.—Four species belonging to the genera *Centrolene* and *Centrolenella* have been recognized in the Fauna of Costa Rica. These are *Centrolene prosoblepon* (Boettger), *Centrolenella pulveratum* (Peters), *Centrolenella valerioi* (Dunn), *Centrolenella fleischmanni* Boettger. Four forms are described as new in the genus *Centrolenella*. These are *C. spinosa, C. granulosa, C. albomaculata* and *C. colymbiphyllum,* all from Costa Rica.

Twenty-five specimens of small, green, hylid frogs taken in Costa Rica in the summer of 1947, resolve themselves into a group of species, one of which is referable to the genus *Centrolene*, since a humeral protuberance is present, and the others to the genus *Centrolenella* in which the protuberance or hook is absent. One of the species possesses a rudiment of a pollex with a sharp spine usually penetrating the free tip. While I am inclined to regard this development as worthy of generic designation, I am for the present referring the species to *Centrolenella* pending further research in the matter.

Three species have already been described from Costa Rica. These are *Hyla prosoblepon* Boettger, in 1892, from Plantage Cairo (La Junta) near Limón, Atlantic side of Costa Rica; Carl Fleischmann collector; *Hylella fleischmanni* Boettger, in 1893, from San José, Costa Rica, Carl Fleischmann collector; and *Centrolene valerioi* Dunn, in 1931, from La Palma, Costa Rica, Manuel Valerio and E. R. Dunn collectors. A fourth species has been reported in Costa Rica. This is *Hyla pulverata* Peters, described in 1873, from Chiriqui, Panamá, H. Ribbe, collector. The present designations of the four species occurring in Costa Rica are: *Centrolene proseblepon*

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(Boettger), *Centrolenella pulveratum** (Peters), *Centrolenella valerioi* (Dunn) and *Centrolenella fleischmanni* (Boettger).

A free translation of the original description of *Hyla pulverata* Peters follows:

Vomerine teeth in two groups between the choanae which are much larger than the small openings of the Eustachian tubes. Tongue scarcely emarginate behind. Snout, not longer than the eye, with a rounded canthus rostralis. Tympanum round, very small, and covered over with pigmented skin. Back smooth, the belly and underside of thigh granular; first and second fingers apparently equally long, much shorter than the fourth; first finger entirely free; the web between the second and third fingers reaches almost to the terminal pads of the second and somewhat over the base of the first joint of the second; between the third and fourth from the terminal disk of the fourth to the middle of the penultimate phalanx of the third. The toes are bound with a complete web which leaves only the two outer joints of the fourth toe free.

Colorless, with scattered small white punctations which are numerous on the side of the head. Under a lens the surface is seen to be punctate with dark flecks.

Total length in mm., 24; head, 9; head width, 8; arm, 15; hand, with third finger, 8; leg, 45; foot and fourth toe, 20.

One specimen from Chiriqui, from H. Ribbe. This species in its form and tooth arrangement is nearest *H[yla] rodopepla,* while its color recalls *H. punctata* and *albomarginata.* The very well-developed web between the fingers and the very small tympanum without a skinfold over it serves to separate them easily.

I have not been able to recognize this species in any of my Costa Rican material. Among the specimens at hand are several species which do not conform to either structures or color of the described forms and I conclude that they represent undescribed species, and are here described.

Centrolene prosoblepon (Boettger)

Hyla prosoblepon Boettger, Katalog der Batrachier—Sammlung in Museum der Senckenbergischen Naturforschenden Gesellschaft in Frankfurt am Main, Aug., 1892, p. 45. (Type locality, Plantage Cairo [La Junta], near Limón, Atlantic side of Costa Rica): Günther, Biologia Centrali-Americana, Reptilia and Batrachia, Sept., 1901, p. 280.

?Hyla puncticrus Boulenger, Ann. and Mag. Nat. Hist., ser. 6, vol. 18, 1896, p. 341.

Centrolene prosoblepon Noble, Proc. Biol. Soc. Washington, vol. 37, 1925, pp. 66-71.

A series of eight specimens from Isla Bonita (The American Cinchona Plantation), display varying shades of lavender, and different degrees of spotting.

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* There is some doubt as to whether there is a humeral hook present in *pulveratum.* Peters makes no mention of this organ. This of course may be accounted for if the type is a female—a strong probability since the vocal sac is not mentioned either.

Dunn, 1931b, who believes he has recognized this form in specimens from El Valle de Antón and in Costa Rica, states that "a rudimentary humeral hook, not projecting" is present; and later Dunn (1933) in listing characters of the form, states "male and female without humeral hook." I am presuming that the last statement is correct, and am referring the species to *Centrolenella.*

Two females, the largest specimens, have the darkest shade of lavender. The exposed surfaces of the back and limbs have small, rounded, purplish or purplish-brown spots. The males, which on the whole are of a lighter shade of lavender, have the spotting similar to that in the females in two specimens, while in four the spots are fewer in number and confined to the rump and dorsal surfaces of the limbs.

The largest male, with a very well-developed humeral process, has no trace of vomerine teeth but they are present in all other specimens. The two females show no trace of the humeral process.

Noble and Dunn both report that the humeral process is present in certain females of a species they identify as *Centrolene prosoblepon*. One wonders whether there is an unrecognized species in Central America in which this is a constant character in females or whether the so-called females with the humeral process represent some type of intersex.

The measurements of the type, as recorded in the type description, is appended to the following table of measurements. It may be noted that the measurement of the arm of the type is considerably smaller than that of specimens of smaller snout-to-vent measurement in this series; the leg is slightly smaller, the head length a little shorter, and the head width a little greater.

The type is from near sea level while the specimens listed here come from an elevation of about 5,500 ft. on Volcán Poas. Whether or not direct comparison with the sea level population would reveal other significant differences cannot be stated.

Centrolene prosoblepon Boettger

		Total length	*Head length*	*Head width*	*Arm*	*Hand and fingers*	*Leg*	*Foot and toe*	*Tibia*	*Femur*
23806	♀	27.5	9	9.5	18	8.5	46	20	15	15
793*	♀	26.5	9	9.8	16	10	46.2	20	15.2	15
2922	♂	26.5	8.4	9.2	18	8	46	19	14.6	13
23804	♂	26	8.3	9	17	8	46	19.4	14.6	13
2926	♂	25	8.3	9	17	8	46	19	14.4	14
23803	♂	25	8.2	9	16	8	45	19	14.2	13.8
23805	♂	24	8	8.5	17.5	7.9	43	19	14	12.8
794	♂	23.4	7.9	8.5	17	7.8	43	19	14	13
Type		24.5	7.5	9	14.5	...	42	....	....	....

* Nos. 793, 794, 2922, 2926 are field numbers of R. C. Taylor.

Centrolenella spinosa sp. nov.

Type: University of Kansas Museum of Natural History no. 23809 ♂. Collected at Los Diamantes, one mile south of Guápiles, Costa Rica, Sept. 7, 1947, by Richard C. Taylor and Edward H. Taylor.

Paratypes: Nos. KU 23810, KU 23811; RCT 2467-2469 (all males). Same locality and collectors. Sept. 7-8, 1947.

Diagnosis: A small species (about 21 mm.); snout high, the front edge nearly vertical; nostril near front edge of snout. Vomerine teeth very weak, usually present; tympanum present; skin minutely rugose but not granular on back and sides; a well-defined pollex rudiment bearing a sharp spine which may or may not be exposed; lavender without any spotting; eyelids purple; iris silver with purple reticulation; inner toe narrowed at tip.

Description of the type: Head broader than the body; eyes prominent, directed somewhat forward; canthus rostralis apparent, very much rounded; areas about nostrils much swollen with a distinct medial depression between them; loreal region with a long slope to lip, the medial area behind nostril slightly concave; snout in front of nostrils nearly vertical, the nostrils much nearer median point of upper lip than eye; interorbital width greater than the length of snout, one and three fourths times width of an eyelid; tympanum present, its greatest diameter about one and three fourths times in its distance from eye, almost three times in longitudinal diameter of eye; a rather marked constriction of head behind tympanum, with a somewhat swollen area above arm insertion; supratympanic fold obsolete; tongue rather rounded with a scarcely discernible notch behind, free behind for about one fifth its length; openings to vocal sacs are elongate curved slits beginning along sides of tongue and extending some distance behind; choanae large, round, the diameter of one contained in distance between them three times; external vocal sac forming ample folds on chin.

Upper arm very slender, the forearm greatly thickened with an indistinct flattened skin fold on under surface; only a faint trace of web between the first and second fingers; a small but distinguishable web between the second and third with a moderate fringe reaching terminal pad on outside of second finger; third and fourth fingers about half webbed, the web not reaching the level of the outer subarticular tubercles; finger widened at tips, and more or less truncate; first finger much longer than second with a distinct rudiment of pollex, free at tip, with a sharp, strong spine (possibly absent in female; none seen); pollex surrounded by the elongate palmar tubercle; a stongly-defined rounded median palmar tubercle; subarticular tubercles well defined and numerous; supernumerary tubercles present; legs long, the tibiotarsal articulation

reaching slightly beyond snout tip when limb is adpressed; the heels touch but do not overlap; foot a little more than three fourths webbed, the terminal pads smaller than those on fingers, the outer somewhat truncate, that on inner toe somewhat pointed, scarcely or not as wide as toe; moderate inner metatarsal tubercle elevated but little; apparently no trace of an outer tubercle; subarticular tubercles small, supernumerary tubercles not or scarcely discernible; inner tarsal fold very weak, scarcely discernible; anal opening high on rump covered by a free flap, the transverse free edge much longer than width of flap.

Skin on back and sides seen under a lens, minutely rugose, but definitely not granular; belly and under side of thigh strongly granular, the granules of the latter much the larger.

Color: In life, yellow green except concealed surfaces of arm, leg, and under side of body which are flesh white, and transparent, without markings; a large light cream spot in front of arm insertion. In preservative (formalin, then alcohol) the dorsum nearly uniform lavender, the eyelids deep purple; limbs lighter but with a fine peppering of lavender chromatophores on the exposed surface, even on most of upper surface of the thigh; below and on concealed surfaces pure white without pigment; iris of eye silver with purple venation; upper lip white.

Measurements in mm.: Snout to vent, 20; width of head, 7; arm, 13; leg, 35.5; axilla to groin, 10.2.

Variation: The five paratypes are all males and agree with the type in essential details, such as in the constriction on sides of head behind the tympanum, forward position of nostril, and the narrow tips of inner toes; the vomerine teeth appear to be present in all but are completely transparent and scarcely discernible save under high magnification.

The spine of the pollex is transparent, sharp and in certain cases does not seem to have pierced the surface of the skin. I presume that this serves as a "grasping" organ in mating and that the spine pierces the skin surrounding it during this act. If it is present in the female it will probably be found to be much reduced. The base of the first finger lacks nuptual asperities although one can discern a group of small spherical glands below the skin in the region where they normally occur in certain other species.

This form stands in relation to *Centrolenella* much as *Plectrophyla* does to *Hyla,* and probably merits a generic designation. However, the pollex character may be present but overlooked in certain species

referable to the group, and a generic name may already be available. Until this is ascertained I shall leave it in *Centrolenella.*

Centrolenella colymbiphyllum sp. nov.

Type: University of Kansas Museum of Natural History, no. 23812 collected at the American Cinchona Plantation, elev. 5,600 ft., Caribbean drainage of Volcán Poas, Costa Rica, July 29. Richard C. Taylor and E. H. Taylor collectors.

Paratypes: Nos. RCT. 790-791. Same data as type.

Diagnosis: Tympanum moderately distinct, its diameter in diameter of eye at least 2.5 times; width of an eyelid in narrowest interorbital width 1.25 times; frontal region shallowly concave, the areas about nostrils strongly swollen with a depression between; canthus indistinct, concave; skin below anal opening forming vertical folds extending under thigh; tibiotarsal articulation 2 mm. beyond snout; terminal disks of hand wider than digits, fingers less than one half webbed; choanae large, the diameter of one contained in distance between them slightly less than two times; no trace of humeral process; no free pollex rudiment; vomerine teeth absent.

Description of type: Adult male; vocal sac forms ample folds on chin and throat. Head a little broader than the body; eyes prominent, directed forward; rounded outline of jaw seen from above interrupted by snout which extends a little farther forward than edge of mouth; interorbital width small, about one fourth greater than width of an eyelid, slightly greater than distance between eye and nostril; frontal region slightly concave; the canthus rostralis indistinct, strongly concave; lores oblique, not or but very slightly concave; nostril distinctly nearer median edge of lip than eye; a distinct depression between the swollen areas of nostrils; eye purplish black, the color showing through eyelids so they appear dark. Lower part of tympanum distinct, largely directed upward but apparently covered with thin slightly pigmented skin, the inner edge more heavily covered.

Tongue subcircular, more or less emarginate on posterior edge, free only for about one sixth of its length; openings to vocal sac elongate slits extending along sides of tongue and somewhat behind; choanae very large, their diameter slightly more than half distance between them; vomerine teeth absent.

Upper part of arm very slender, forearm thickened with a strong fold on its outer edge, without a thin flap indicated at elbow; median palmar tubercle very distinct; inner tubercle rather indistinct, lack-

ing nuptial rugosities but with the minute glandules visible under the skin; toes broad, terminal disks distinctly wider than digits, the width of outer finger disk equal to half eye diameter; outer fingers little more than one third webbed; a trace of web between first two fingers. Leg elongate, the tibiotarsal articulation reaching 2 mm. beyond tip of snout; heels barely touch when legs are folded at right angles to the body; a flat rather large inner metatarsal tubercle; outer tubercle if present very indistinct; toes nearly three fourths webbed except that first two have webs extending scarcely half their length.

Skin not granular, but under lens some minute elevations visible, each with a medial depression suggesting a crater; chin and throat smooth; abdomen areolate; a very small areolate area on under surface of thigh; skin below anus forming vertical folds, noticeable when femurs are at right angles to body.

Color: In life, uniform bright yellow green on back and sides, with dim suggestions of cream flecks; on ventral surfaces whitish, semitransparent; tips of toes yellowish. In preservative (formalin transferred to alcohol), nearly white with numerous star-shaped chromatophores and indications of small rounded areas without pigment; under surfaces flesh-white without pigment; a very narrow line of chromatophores on dorsal surface of thigh.

Measurements in mm.: Snout to vent, 26; head length, 7.8; arm, 18; leg, 43.

Variation: The two paratypes taken at the same time and place differ negligibly, save that the tympanum is a little smaller and a little less distinct, and the tibiotarsal articulation reaches only to the tip of the snout. The measurement variations are given in the following table:

Centrolenella colymbiphyllum sp. nov.

No.	*Total length*	*Head length*	*Head width*	*Arm*	*Hand and fingers*	*Leg*	*Foot and toe*	*Tibia*	*Femur*
791	26	7.8	9.5	18	8	46.2	20	15	13.7
790	25.8	8	9.2	18	8	43	18.8	13	12.8
23812	25	7.4	9	16.5	7.7	44	19	13.8	13.5

Remarks: Centrolenella albomaculata differs from this form in having the snout less protruding, the hand more than half webbed, the feet four fifths webbed, the vomerine teeth present, and the nostril closer to the eye. The dorsal color is lavender dotted with numerous cream spots. The eyelid is purplish black.

Centrolenella granulosa differs in having the dorsum strongly granular, the nostrils closer to the eye than middle edge of lip, the

snout sloping obliquely in front of the nostrils, the vomerine teeth present and the choanae much farther apart. The webbing on hand and foot is distinctly greater.

Centrolenella valerioi differs in having a very small tympanum (one sixth the eye diameter), and the interorbital space twice width of an eyelid.

C. fleischmanni differs in having the eyelid golden, the under surface of the thigh very strongly areolate on the entire under surface, a distinct outer metatarsal tubercle present, choanae farther apart, and the frontal area not concave. Both species have the vomerine teeth absent and the degree of webbing about the same.

The character of the pollex in *C. spinosa* distinguishes that form from all other members of the genus.

The presence of vomerine teeth, numerous white punctations below the eye and the granulation of the underside of the thigh distinguishes *C. pulveratum.*

The specimens were collected at night from leaves of plants growing in a small mountain stream. They appeared to be very wary and numerous individuals dived into the water and escaped. In the same identical habitat a series of *Centrolene prosoblepon* were taken. These were apparently less wary and more easily captured.

There is a vague possibility that *C. colymbiphyllum* is identical with Boulenger's *Hyella punctiorus* that has been synonymized with *Centrolene proseblepon* by Neiden (1923).

Centrolenella fleischmanni (Boettger)

Hylella fleischmanni Boettger, Ber. Senck. Naturf. Gesells., 1893, pp. 251-253. (Type locality, San José, Costa Rica.)

Centrolenella fleischmanni Noble, Proc. Biol. Soc. Wash., vol. 37, 1924, p. 69 (combination suggested).

Three typical specimens are from the environs of Cartago, Costa Rica. They were taken from low branches above flowing water on a rainy evening.

Centrolenella valerioi (Dunn)

Centrolene valerioi Dunn, Occ. Papers Boston Soc. Nat. Hist., vol. 5, 1931, pp. 397-399. (Type locality, La Palma, Costa Rica.)

A single specimen was obtained at El General, Costa Rica, clinging to a leaf of a plant growing in the mire about a small spring. The dorsal color in life was green with some slightly reticulated lighter green markings. The eye was golden.

In preservation the specimen is nearly white, peppered with fine purplish flecks; the area above the eye is cream white but bearing purplish flecks; the pupil is gray and lavender.

The specimen measures 20 mm. snout to vent; width of head, 7.5 mm.; arm, 13 mm.; leg, 32 mm.

The tympanum is visible but covered with skin and measures approximately 1/5 of the diameter of the eye.

It bears considerable resemblance to *Centrolenella fleischmanni*, but the arms and legs are proportionately longer and the tympanum is present.

Centrolenella granulosa sp. nov.

Type: R. C. T. no. 2463. Collected at Los Diamantes one mile south of Guápiles, Costa Rica, Sept. 7, 1948, by Richard C. Taylor.

Paratype: University of Kansas no. 23802. Collected with the type; same collector.

Diagnosis: A rather large species of the genus (28 mm.) with strongly granular skin on head, back and sides of body, dorsal part of limbs, venter and undersurface of thighs. Large vocal sac, its surface rugose. Web on outer fingers extending beyond level of the two outer subarticular tubercles; between second and third fingers, 1/5 webbed with broad fringe on outer side of second finger; scarcely a trace of web between first and second; nuptual asperities on thumb; large inner, very small outer metatarsal tubercle; no projecting rudiment of a pollex; tibiotarsal articulation 2 mm. beyond tip of snout; nostrils equidistant from eye and median tip of snout; eyelid purple, body (in alcohol) creamy white with numerous scattered purple or lavender spots.

Description of type: Head broader than body, the eyes strongly protruding, directed somewhat forward, the pupil horizontal; canthus rostralis distinct, slightly rounded; area about nostrils somewhat elevated with a slight depression between them; in front of nostril, snout slopes forward and down to edge of lip; loreal region sloping more gradually to lip; interorbital distance about 1 to 1½ times width of eyelid; tympanum present, its diameter practically three times in longitudinal diameter of eye; a supratympanic fold from eye to near insertion of arm.

Tongue cordiform, slightly notched behind; opening to vocal sacs are curved slits reaching from level of middle of tongue to considerable distance behind tongue; choanae large, circular, the diameter of one contained in distance between them four times; two very indistinct vomerine ridges between choanae, each bearing two or three vomerine teeth.

Fingers short and broad, the tips dilated, that of fourth finger one half diameter of eye; a mere trace of web between first and second fingers; about one fourth to one fifth webbed between second and third but a rather distinct fringe reaches to terminal pad on outer side of the second; between third and fourth a little more than two thirds webbed, a fringe reaching terminal pad on outer side of third finger; subarticular tubercles well defined; a large, very distinct oval palmar tubercle; large tubercle at base of first finger bearing colorless nuptual asperities which extend much beyond tubercle and across the dorsal surface; a strongly defined fold on underside of forearm.

Legs long, the heels overlapping little more than two millimeters; tibiotarsal articulation extends beyond tip of snout about two or three millimeters; toes three fourths to four fifths webbed; subarticular tubercles distinct, rather large; a strong inner metatarsal tubercle; and a very small outer; a very slight, scarcely distinguishable inner tarsal fold.

Granulations on skin strongly defined on back, sides, head, and to a lesser extent on surface of forearm and lower part of leg and foot; on throat and chin, skin rugose but apparently not granular; venter and the greater part of underside of thigh, strongly areolar or granular, the granules being very much larger than those on back; those under the thigh distinctly larger than those on venter; a narrow, but relatively long transverse free flap covers anal opening.

Color: In life, leaf green with some slightly darker areas evident; below transparent white or flesh; in preservative (formalin transferred to alcohol) color cream flesh with a very faint wash of lavender with numerous (about 40) small purple spots; under a lens the lavender wash is seen to be caused by very numerous, small chromatophores. All ventral surfaces, and much of the lateral surfaces of limbs and body, cream-white lacking pigment; eyelids purple; eyes silver with some purplish reticulation.

Measurements in mm.: Snout to vent, 28.2; width of head, 10; axilla to groin, 16; arm, 18; leg, 49.

Variation: The paratype is somewhat more lavender than the type. The dorsal spots are smaller and more numerous on the back and on the tibia. The iris of the eye is darker; the vomerine tooth patches are more distinct. Otherwise the two agree in all essential details.

Remarks: The absence of a humeral hook or process places this species in the genus *Centrolenella* Noble. Noble regarded the ab-

sence of vomerine teeth a character of the genus. However the teeth are not invariably present. The teeth may be absent in some individuals of a species and present in others.

The position of the nostril, halfway between eye and the median tip of snout, the purple eyelid, the very granular skin, the longer leg, presence of a tympanum, absence of a pollex rudiment, and the markings, will together distinguish this form from other species of *Centrolenella*.

The specimens were taken at night on small trees growing on the edge of a small river.

Centrolenella albomaculata sp. nov.

Type: University of Kansas Museum of Natural History no. 23814. Los Diamantes, one mile south of Guápiles, Costa Rica, Sept. 7, 1947, E. H. Taylor and Richard C. Taylor, collectors.

Paratype: R. C. T. no. 2020. Same date, locality, and collectors.

Diagnosis: A rather large sized species of the genus (27 mm. snout to vent); tympanum distinct, nostrils slightly closer to eye than to median point of snout at tip; interorbital distance equal to width of eyelid; heels overlapping; tibiotarsal articulation 4-5 mm. beyond tip of snout; toes five sixths webbed, the membrane touching the terminal expansions on one side or other of all toes, save fourth; a distinct web present at base of first and second fingers; posterior part of back slightly but indistinctly granular; vomerine teeth strongly developed in two ridges near posterior level of choanae. No pollex rudiment; purplish lavender with numerous cream spots on all unconcealed dorsal surfaces.

Description of type: Head a little wider than body, the eyes large, protruding, their diameter equal to their distance from tip of snout; areas about nostrils strongly swollen, with a strong depression between and somewhat behind them; canthus rostralis wanting; in front of nostrils the snout slopes to the edge of lip at an angle distinctly greater than slope of loreal region; lores distinctly concave; tympanum small, its greatest diameter contained in distance from eye one and three fourths times, and in the longitudinal diameter of eye a little more than three times.

Tongue rather rounded, not or but very slightly emarginate posteriorly, free for about one fifth its length; opening of vocal sacs elongate, curved slits lying partly at side of tongue and extending some distance behind; choanae large, their diameter contained in space between about three times; vomerine teeth in two raised

patches lying between the posterior level of choanae and extending somewhat behind this level; (in paratype not reaching posterior level of choanae).

Digits short, widened at the tips, that of third finger a little more than one half eye diameter; a very narrow web between first two fingers; second and third fingers one third webbed, the web extending as a fringe to the terminal expansion on outer side of second finger; third and fourth toes two thirds webbed, the web extending beyond level of subarticular tubercles; latter strongly developed; an elongate pad at base of first finger and very distinct palmar pad at base of wrist; base of first finger with an area of nuptial asperities; supernumerary tubercles indistinct; upper arm slender, forearm thickened with a well-developed fold on under side; legs long and slender, the tibiotarsal articulation extending several millimeters beyond tip of snout when leg is adpressed to body; heels overlap 2.2 mm.; toes four fifths webbed, the web reaching the terminal pad of each toe on one side, except fourth; terminal pads truncate, that of inner toe rather pointed; a rather large inner metatarsal tubercle, rounded anteriorly, the tip slightly free; outer, if present, very indistinct; subarticular tubercles well developed; some distinct supernumerary tubercles; inner tarsal fold scarcely indicated.

Skin with some indistinct granulation on posterior part of back; slightly rugose anteriorly and on sides of body; upper surface of limbs also slightly rugose; throat and breast smooth; abdomen granular as is the greater part of under side of thigh; an enlarged granule on each thigh medially; segmentation of abdominal muscles distinctly indicated on venter; a small free flap over anal opening.

Color in life: Yellow green on all exposed surfaces, with indications of small cream dots; all concealed surfaces creamy white nearly transparent; in preservative (formalin transferred to alcohol) purplish to dark lavender above, somewhat lighter on the upper surface of limbs with very numerous rounded cream spots or punctations, somewhat larger on hind limb than on back; venter and under surface of limbs cream white; eyelids dark purple with white flecks; iris purple with minute silver flecks; some white flecks in tympanic and anal regions.

Measurements in mm.: Snout to vent, 26; width of head, 9; arm, 19; length of hind limb, 50; axilla to groin, 14.

Variation: The single paratype collected in the same locality with the type agrees in all essential details save that the vomerine

teeth are somewhat farther forward; and outer metatarsal tubercle is indicated. The color has been somewhat changed due to rust in the preserving fluid.

A key to the recognized species (for preserved material) is here given:

1. Humeral hook in males; color lavender with numerous small purple spots and minute chromatophores; nostrils far forward, nearer median edge of lip than eye; tympanum distinct; type 24.5 ♂; greatest length, 27.5 ♀ ... *Centrolene prosoblepon*
   No humeral hook in males 2
2. A rudiment of a pollex present, free at tip, terminating in a sharp firm spine in males, condition in females not known; skin of back and sides under lens minutely rugose but not granular; snout nearly vertical in front, nostrils nearer median point of lip than eye; lavender with neither light nor dark spots (females not known); vomerine teeth present; length, 21 mm. ♂ ... *Centrolenella spinosa* sp. nov.
   No free rudiment of pollex bearing spine 3
3. Tympanum concealed; vomerine teeth absent; nostrils not elevated; color cream-flesh, unspotted but with numerous lavender or purple chromatophores visible under lens; upper eyelid golden yellow or creamy yellow ... *Centrolenella fleischmanni*
   Tympanum not concealed; vomerine teeth present or absent 4
4. Tympanum minute, one sixth of eye diameter or "very small" 5
   Tympanum larger, at least one-third of eye diameter 6
5. No vomerine teeth present; first finger longer than second; canthus distinct but rounded; outer fingers about one-half webbed; interorbital space twice width of an eyelid; heel reaches beyond snout; skin smooth above; white with a few faint dark [purplish?] chromatophores; type, 21 mm.; sex not mentioned. (Said to reach 26 mm.) ..... *Centrolenella valerioi*
   Tympanum very small covered with pigmented skin; vomerine teeth present; back smooth; first and second fingers equally long; outer fingers about ½ webbed; toes except fourth nearly completely webbed; colorless with scattered small punctations, numerous on the side of head ..... *Centrolenella pulveratum*
6. Vomerine teeth absent; skin lacking granules on back; nostril much nearer median edge of lip than eye; interorbital space one fourth wider than an eyelid; outer fingers less than half webbed; diameter of choanae in distance between choanae minutely less than two times ..... *Centrolenella colymbiphyllum*
   Vomerine teeth present; dorsal skin more or less granular; nostril nearer eye than median edge of lip 7
7. Skin strongly granular above; nostrils nearer eye than tip of snout; tip of snout oblique, not vertical; vomerine teeth weakly developed; white or slightly lavender with numerous purple spots, and finely scattered lavender chromatophores; outer fingers two thirds webbed; eyelid deep purple; 28 mm. ♂ ..... *Centrolenella granulosa* sp. nov.

   Skin weakly granular on posterior part of back, somewhat rugose anteriorly and on head; vomerine teeth strongly developed; tibiotarsal articulation 4-5 mm. beyond snout; interorbital width equal to width of eyelid; diameter of tympanum in eye diameter a little more than three times; nostril minutely nearer eye than lip; lavender above, with numerous cream spots on all exposed surfaces; type, 27 mm. ..... *Centrolenella albomaculata* sp. nov.

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Two New Teiid Lizards from Costa Rica

BY

EDWARD H. TAYLOR

ABSTRACT.—Two species of lizards belonging to the Family Teiidae are described as new. One species, *Alopoglossus plicatus,* is the first record of that genus on the North American continent. The second species, *Leposoma bisecta,* is the second species of that genus known north of the Isthmus of Panamá.

The lizard family TEIIDAE, which apparently has undergone the greater part of its evolution in South America, is represented there by about 28 known genera, a number greater than is possessed by any other South American lacertilian family at the present time. Eight genera have entered the isthmus and have pushed various distances to the north. These are *Cemidophorus*, a genus widespread in Central America, Mexico and the United States; *Ameiva,* a genus with several representatives in Central America and Mexico extending far to the north in eastern Mexico; a third, *Gymnophthalmus,* reaching at least to the isthmus of Tehuantepec; *Leposoma* and *Anadia,* known to have reached as far north as Costa Rica, and *Echinosaurus* and *Ptychoglossus* known in Panamá.

A species encountered in the east slope drainage of Costa Rica at an elevation of about 2,600 feet is referred to the genus *Alopoglossus* and is here described as new. There may be some doubt about the use of *Alopoglossus* for those lizards having chevron-shaped plicae on the tongue instead of scales; Boulenger recognized the genus *Alopoglossus* for these forms, but Burt and Burt (1931) synonymized it with *Pantodactylus* Duméril and Bibron. The differences apparently are of generic significance.

Alopoglossus plicatus sp. nov.

Figure 1.

Type: University of Kansas Museum of Natural History, no. 23800. Taken on the Morehead Finca, 5 miles southwest of Turrialba, Costa Rica, July 21, 1947, by Edward H. Taylor.*

Diagnosis: Dorsal scales around body forming nearly regular transverse and oblique keeled series; 30 scales from occiput to base of tail; 24 scales from chinshields to anals; 33-35 scales around body at middle, all strongly keeled save on belly; keels terminating in spines, the spine reduced or absent on lateral rows; ventrals in four regular, longitudinal, smooth, quadrangular rows, outer larger than inner; gular collar indicated; four supraoculars; venter cream with dark spots or flecks in males (female may be white below).

Description of the type: Rostral nearly twice as wide as high forming a straight (or very slightly curved) suture with the frontonasal; latter large, in contact laterally only with nasal; prefrontals pentagonal, touching only preocular and first supraocular laterally; frontal wider near anterior end than at posterior end, sides slightly concave, ends broadly angular, in contact with three supraoculars; two frontoparietals, larger than prefrontals but at least one fourth smaller than frontal; parietals large, longer than wide, much larger than other head scales, angular at anterior end, somewhat rounded posteriorly, and separated from each other by a large parallel-sided interparietal.

Nasal large, triangular, at least partially divided by a suture running up from nostril; a rectangular preocular much higher than wide; four supraoculars, four superciliaries, anterior largest; 2 rows of ciliaries on upper eyelid; lower eyelid with a more or less transparent disk divided into three parts; 2 presuboculars precede an elongate curved subocular; 3 presuboculars, the upper touching the anterior superciliary; a small "loreal."

Seven upper labials, third greatly elongated, lying for the most part below eye; mental deeper and wider than rostral; six lower labials; large azygous postmental followed by three pairs of chinshields, first and second pairs in contact mesially and in contact with labials laterally, third pair separated mesially from each other and from labials laterally, followed by an enlarged pair of scales separated mesially; six transverse rows of smooth scales between

* The University of Kansas Natural History Museum wishes to acknowledge financial aid to the Endowment Association of the University of Kansas, in the making of collections in Costa Rica.

this last pair of scales and the groove formed by gular collar; six rows of temporal scales, posterior scale of upper row largest, somewhat ridged; some slight ridges on some of the other temporal scales; auricular opening large.

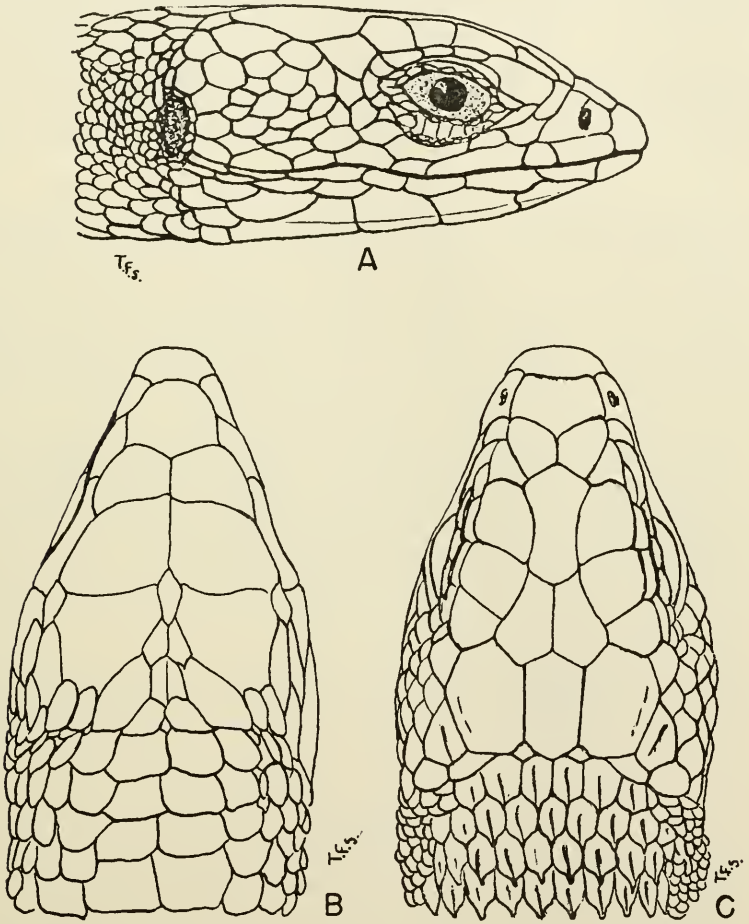

FIG. 1. *Alopoglossus plicatus* sp. nov. Univ. Kansas Nat. Hist. Mus. no. 23800 Type. Five miles southwest Turrialba, Costa Rica. A. Head lateral view. B. Head ventral view. C. Head dorsal view. (Slightly diagrammatic.) Snout to ear length 11.6 mm.

Dorsal scales strongly keeled, their sides more or less parallel, terminating in a spine, continuing to tip of tail; scales forming transverse rows. Lateral scales on neck small, smooth, irregular in size; around arm insertion a rather large granular area present, and a similar one of lesser extent about leg insertion.

Ventral scales of breast and abdomen large, quadrangular, smooth, beginning at collar where scales are slightly curved, and continuing back to level of thigh, arranged in four longitudinal rows and sixteen transverse rows, the outer larger than inner; outer row on each side bordered by a series of somewhat enlarged scales about one half as wide; scales under tail smooth; four elongate anal scales, outer smaller than inner, separated from the last modified row of the abdominal series by a row of small scales, two on each side, bearing femoral pores; total series of femoral and preanal pores 12 (13) on each side.

Arms and legs moderately developed, pentadactyl; digits well developed and clawed; anterior surface of arm with large, smooth, irregularly-shaped scales; those on back and ventral surface much smaller; front scales on thigh smooth and large; dorsal scales on thigh smaller, strongly keeled; posterior thigh surface covered with granular scales; under surface of tibia with large smooth scales; those on other surfaces smaller, keeled; two enlarged scales, each with a sharp cutting edge, at base of first finger.

Each side of tongue decorated with a regular series of plicae that run forward to medial line, forming 24 chevrons; posteriorly there are eight or nine rows on each side that fail to meet in the middle.

Measurements (in mm.): Snout to vent, 50; snout to arm, 19.2; axilla to groin, 25; head width, 8.4; snout to ear, 11.6; tail, 60 (regenerated); arm, 13; leg, 19.5.

Color in life: Head nearly uniform mahogany brown, slightly darker in supraorbital region; back slightly reddish-brown with numerous dark flecks; a dorsolateral light line from above tympanum to behind level of arm insertion; sides blackish, but with very numerous cream-white flecks, some suggesting lines; venter cream with numerous black spots or flecks; black marks on the ventral scales are largely on scale edges and these, being contiguous, tend to form irregular black stripes. Chin with rounded dark spots.

Tail partly regenerated, proximal part colored much like body; ventrally, dark spotting tends to form transverse rows of dots or narrow irregular bars; regenerated portion of tail much lighter with a reddish cast; only a few minute dark flecks on sides and a very few on underside. There is somewhat more black mixed in dorsal coloration of body in area between the two anterior dorsal light lines, this area being considerably darker than elsewhere.

Relationship: This species is probably most closely related to

Alopoglossus buckleyi. From the species which Boulenger placed in this genus, *A. plicatus* may be distinguished as follows:

From *Alopoglossus copii* by the presence of quadrangular scales on the neck, rather than the more typical lanceolate triangular, spine tipped scales of *copii.* There are, of course, other differences including a longer series of femoral pores.

From *carinicaudata* it differs in having 33 - 35 instead of 21 scales round the body; and from *buckleyi* in having smooth instead of keeled scales, more scales around body, and a very different coloration.

Variation: The paratype, a young female from the same locality, differs somewhat from the type, but I suspect that this is due largely to age and sex. The lateral groove on the tail is very distinct, and that on the dorsal surface of the tail is a little less distinct than the lateral. The femoral pores are absent and there is a distinct difference in the character of the scales that precede the anal scales. These are proportionately much larger, while the preanal scales are distinctly smaller than in the type.

In this paratype, there are 34 scale rows around the middle of the body and 27 between the chinshield and the anal opening. The scales of the row bordering the outer of the four median ventral scale rows is distinctly larger than in the type and one might well count six ventral rows instead of four.

The ventral surface of tail and body are immaculate cream; the chinscales have a few black spots. It is possible that adult females may develop more pigment on the venter. On the other hand it is not impossible that a second form is involved. Only larger series can determine this beyond question.

Leposoma bisecta sp. nov.

Type: University of Kansas Natural History Museum, no. 23801, collected on the Pacific slope, ½ mile west of El General, Costa Rica, at an elevation of about 300 meters, Aug. 21, 1947, by Edward H. Taylor.

Diagnosis: A species characterized by a large divided frontonasal, narrowed anteriorly; the scales of head strongly striate longitudinally; ventral scales and gular scales all very strongly keeled; four supraoculars; prefrontals short, as wide as long; no postfrontal; four preoculars; a pair of frontoparietals; interparietal larger than parietals. Dorsal scales large, more than three fourths as broad as long, heavily keeled and with a short posterior spine, forming

transverse and oblique rows on back and sides. No trace of a gular collar.

Description of the type: Rostral slightly more than twice as wide as high; frontonasal divided into two elongate scales narrowing anteriorly; a pair of prefrontals nearly as broad as long, in contact with each other for a little more than half their length (due to an injury one is partially fused to frontal); frontal concave laterally, broadly angular anteriorly and posteriorly, one and one third times

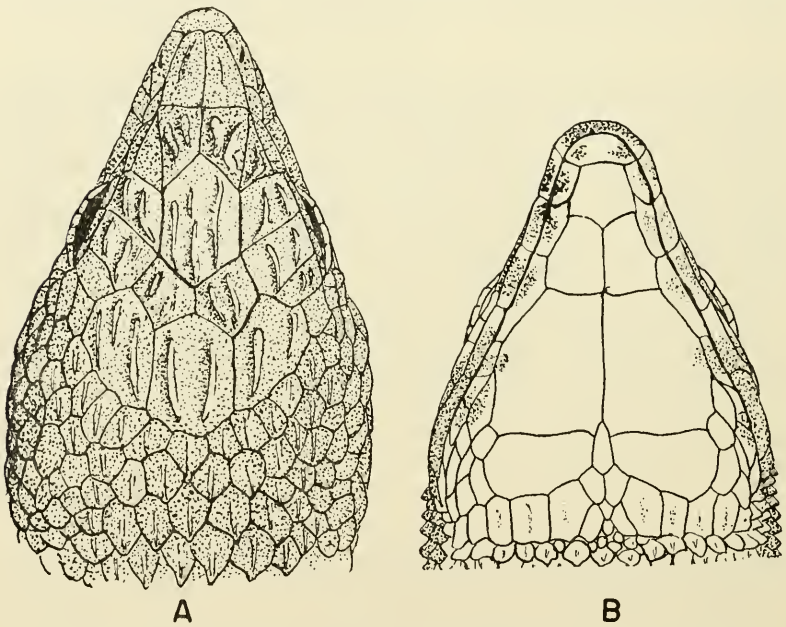

FIG. 2. *Leposoma bisecta* sp. nov. Univ. Kansas Nat. Hist. Mus. no. 23801, Type. El General, Costa Rica. A. Head dorsal view. B. Head ventral view. Actual head width 6.7 mm. (Slightly diagrammatic.)

as long as wide; frontoparietals pentagonal, in contact with each other for half their length; interparietal larger than the parietals and separating them. Scales following the parietals and interparietal not or but little differentiated from other neck scales; four supraoculars. All dorsal head scales with either two, three or four heavy ridges or keels.

Nostril pierced in a large nasal, which has a slight groove above nostril, suggesting a suture; five scales in combined subocular-preocular series, including "loreal"; four superciliaries; two or three small postoculars not distinguished from other temporal scales;

lower eyelid with a transparent disk divided into two parts; seven upper labials in following ascending order of size: 6, 1, 5, 4, 3, 2, 7; five lower labials; a large azygous postmental followed by two pairs of chinshields which are in contact mesially and border the labials either entirely or partially (second pair); a third pair much smaller, separated from the labials by two or three scales, and from each eath other by a slender elongate scale; each of the third pair followed by three scales, these separated by two or three smaller scales. There follows a row of very small keeled scales that extends to the very large auricular opening. Seven rows of temporal scales; postauricular scales pyramidal or subconical. No trace of a gular collar.

Scales of dorsum large, imbricate, heavily keeled, each terminating posteriorly in a small spine, forming somewhat irregular transverse series and regular oblique series; 26 scales in row about middle of body; 32 scales from occiput to posterior level of thighs; 35 rows from chinshields to preanal pore-scales; four contiguous preanal pore-scales immediately preceding preanal scales. Scales of breast and abdomen arranged in regular transverse series in six longitudinal rows, all keeled strongly, the keel terminating in a spine posteriorly. These scales differ from gular series in having their sides more nearly parallel. Five preanal scales border the vent, arranged as follows, a small median preceded by a larger triangular scale; these two bordered laterally by two elongate widened scales, narrowed at each end; outermost scales small. Femoral pores 7-7, reaching to the continuous preanal pore series of four (2-2).

Limbs pentadactyl, all clawed, inner finger and toe reduced; scales on upper surfaces of arm more or less regular, keeled; those on under surface smaller, some tetrahedral with keels reduced; scales about arm insertion small, more or less tubercular; scales on front and dorsal surface of legs irregular in size, more or less similar in shape; scales on posterior thigh granular with a patch of slightly larger scales; scales in groin, and about leg insertion, smaller.

Tail, regenerated for the most part, somewhat compressed, bearing a more or less distinct lateral groove; scales on regenerated part of tail similar to those of original tail.

Auricular opening very large, nearly equal to eye opening.

Tongue covered with scales; no suggestion of lingual plicae or chevrons.

Color: Dark indefinite brown, the scales with minute black flecks

or punctations; a light, tan, dorsolateral line from middle of neck to some distance on tail, distinct anteriorly, less distinct in middle of body, forming a series of light dots on tail; sides of neck and body darker; head blackish on top and sides; venter light, immaculate, save for a few flecks under tail; regenerated part of tail darker above and below; white spots on upper and lower labials alternate with similar dark areas; a few cream spots on side of neck. Scales or lamellae under feet and toes blackish.

Measurements (in mm.): Snout to vent, 34.5; snout to arm, 13.2; axilla to groin, 17.3; tail (regenerated), 43; arm, 10.2; leg, 13; head width, 6.7; head to auricular opening, 8; head length, 10.

Relationships: I am associating this species with the genus *Leposoma* despite the fact that the frontonasal is paired. On the basis of this character it does not appear to be closely related to other members of the genus.

Remarks: Burt and Burt (1931) give meagre data on two specimens of a *Leposoma* from Suretka, Costa Rica (M. C. Z. nos. 18916-18917), which they refer to the species *Leposoma dispar* Peters. They record certain differences that obtain between the specimens and the type of *dispar,* and it is not impossible that their specimens warrant description under a different name. As far as data is available, the specimens mentioned differ from the type here described as follows:

Specimens Suretka, Costa Rica	Type Specimen of *L. bisecta* El General, Costa Rica
1. Head shields roughened posteriorly.	1. All head shields with one to three strong keels.
2. Twenty-seven to twenty-eight scales from occiput to base of tail.	2. Thirty-two scales from occiput to base of tail.
3. Nineteen to twenty scales about middle of body.	3. Twenty-six scales about middle of body.
4. Thirty to thirty-two scales from chinshields to anals.	4. Thirty-five scales from chinshields to anals.

Apparently they agree in having four supraoculars. They differ, however, in the character of the frontonasal and there may be other unstated differences.

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New Salamanders from Costa Rica

BY

EDWARD H. TAYLOR

ABSTRACT.—A short review of the known species of salamanders of Costa Rica is given, and four new species are described. These are *Magnadigita nigrescens, Bolitoglossa palustris, Parvimolge richardi* and *Oedipina serpens.*

The known salamander fauna of Costa Rica consists of some ten plethodontid species representing several genera. One other species, *Oedipina collaris,* has been reported both in Nicaragua (its type locality) and Panamá, and it may be expected in Costa Rica if its range is continuous.

The following species have been taken, or at least reported in Costa Rica:

Pseudoeurycea? picadoi
?Bolitoglossa platydactyla
Bolitoglossa lignicolor
Bolitoglossa striatula
?Bolitoglossa flaviventris
Magnadigita robusta
Magnadigita subpalmata
Oedipina uniformis
Oedipina alfaroi
Haptoglossa pressicauda

Cope (1876) reported a specimen of *Oedipus morio?* "a partly preserved specimen from the eastern slope of the Pico Blanco." This has been referred to the synonymy of *Oedipus subpalmatus* [=*Magnadigita subpalmata*] by Dunn (1926). Again Cope (1887) lists *Oedipus morio* and includes with the above reference a report of a specimen collected by Zeledon on the "Plateau of Costa Rica."

Günther (1902) reports a species which he designates as *Spelerpes morio* from the plateau of Cartago (Zeledon collector), and seemingly refers to the same material mentioned above. Dunn (1926) has referred this reference to the synonymy of what Dunn designates as *Oedipus morio* (corrected by Schmidt, 1933) to *Oedi-*

pus dunni. Since the reference also contains specimens from Mexico and Guatemala it is not certain whether one may accept the species *dunni* as a part of the Costa Rican fauna or not.

Bolitoglossa platydactyla (*Spelerpes variegatus*) is reported from San Carlos, Costa Rica, by Günther (1902). Dunn (1926) states that he has examined this species and that he identifies it as being *Oedipus platydactyla*. He also identifies two British Museum specimens from Medellín, Colombia, as *O. platydactyla*. If they are correctly identified the extent of the range (from Eastern San Luis Potosí, Mexico, to Medellín, Colombia) is greater than that of any other Central American salamander. He does suggest the possibility that these specimens "may represent an undescribed form." Cope reports the species as *Oedipus variegatus* from Buenos Ayres in southwestern Costa Rica.

A specimen purporting to be from Miravalles, Costa Rica, was referred by Dunn (1926) to *Oedipus salvinii*. Schmidt (1936) has shown that Dunn has confused *Oedipus flaviventris* Schmidt with *Oedipus salvinii* and places *Oedipus salvini* Dunn (part) in the synonymy of the latter. The Costa Rican specimen agrees with *flaviventris* in having the venter "light." Schmidt does not make specific mention of the Costa Rican specimen, but I suspect it should be regarded as *flaviventris* until proved to the contrary. The remaining species of the list seem to be unquestionably a part of the Costa Rican fauna.

Pseudoeurycea? picadoi (Stejneger). The type of this species is from La Estrella, southeast of Cartago, Costa Rica. Specimens have been taken at La Palma, and certain of the type series of *subpalmatus* are said to be of this species (Dunn, 1926, p. 380).

Bolitoglossa lignicolor (Dunn) has been reported, by Dunn (1926), on the basis of a single specimen from Sarapiqui, Costa Rica. The type locality is Chiriqui, Panamá.

Bolitoglossa striatulus (Noble) originally described from Cukra, near Blufields, Nicaragua, is known from a specimen from Turrialba, Costa Rica, and two specimens from Surubres, Costa Rica (Dunn, 1926).

Magnadigita robusta (Cope) was originally described from the slopes of Volcan Irazú, Costa Rica. This is a well-known species and is the largest salamander species occurring in the country.

Magnadigita subpalmatus (Boulenger) was originally described from La Palma, Costa Rica. It is a well-established form but there

is a strong probability that in the literature specimens of other species have been referred to it erroneously.

Oedipina uniformis (Keferstein) was originally described from "Costa Rica." Numerous specimens have been reported. Here again it seems probable that other species have been confused with it in the literature.

Oedipus alfaroi Dunn, is known from the type, from Zent, and two specimens from Suretka, Costa Rica.

Haptoglossa pressicauda Cope is known only from the type, which is now lost.

Günther, in compiling the Reptilia and Batrachia, of the Biologia Centrali-Americana, probably had no more than a dozen specimens from Costa Rica. Dunn, in his "Plethodontidae," lists about 114 specimens from Costa Rica in the material available to him in 1926. All are placed in the preoccupied genus *Oedipus*. This material was distributed as follows:

16 *robustus*	1 *lignicolor*
7 *picadoi*	3 *striatula*
49 *subpalmatus*	1 *alfaroi*
1 *flaviventris* (*salvinii?*)	36 *uniformis*

Besides these, Dunn examined the following Costa Rican specimens: 1 *robustus*, 1 *subpalmatus* and 14 *uniformis* including the type of *Opheobatrachus vermicularis* Gray in the British Museum of Natural History, and mentions that there were other specimens not examined (perhaps some of which may have been from Costa Rica).

In the collection made by the Austrian Biological Expedition of 1930, reported by Wetstein * three species are reported: *subpalmatus*, 10 specimens; *picadoi*, 1; *uniformis*, 1.

The collections made in the summer of 1947 by Richard C. Taylor and myself contain representatives of only four of the known species. No specimens of the reported forms *Bolitoglossa platydactyla, B. flaviventris, Pseudoeurycea? picadoi, Oedipina alfaroi* or *Haptoglossa pressicauda*, were found. However, numerous specimens of the known *Magnadigita robusta, Magnadigita subpalmata, Bolitoglossa striatula* and *Oedipina uniformis* were taken; several others were discovered that are believed to represent undescribed species. A part of these are treated in the following pages.

* Sitz. Akad. Wiss. Wien Abt. 1, Bd. 143, Heft. 1, 2, 1934, pp. 1-39, 9 text figs.

Magnadigita nigrescens sp. nov.

Type: University of Kansas Museum of Natural History no. 23816, collected at Boquete Camp (on highway between Millville and San Isidro El General), Costa Rica, elevation 6,000 ft., Aug. 17, 1947, by Edward H. Taylor.

Diagnosis: Uniformly blackish brown above, slaty black on sides and ventral surfaces; hand and foot webbed, the terminal joint of truncate digits free of web except that of inner digit; thirteen costal grooves; nostril small; paravomerine teeth in a single patch, notched behind; 11-11 vomerine teeth, arranged partly in two series, beginning outside level of choanae, the two series separated by twice the diameter of choanae; no sublingual fold; maxillary teeth reduced, 7-9.

Description of the type: Adult ♀ ; head broad, the snout bluntly rounded, somewhat truncate; a slight swelling on lip below nostril; eye moderate, its diameter longer than snout; posterior part of eyelids fit under a diagonal fold; a strong gular fold on neck with a nuchal groove arising from each side, which meets its fellow on the middorsal line of the neck; anterior to gular fold, a groove completely crosses chin and ascends either side, crossing behind angle of mouth and terminating at the postorbital groove; latter arises at eye, and extends back but does not reach to nuchal groove; a small lateral groove in front of the nuchal groove which reaches to the middorsal line; thirteen costal grooves counting those in axilla and groin; adpressed limbs separated by between two and one half to three costal folds; fold of the posterior extension of the hyoid apparatus reaches second costal fold; tail regenerating presumably, a basal constriction on tail; walls of cloaca with smooth folds; glandular area behind insertion of leg not especially distinct.

Skin generally smooth, but area on snout and interorbital region somewhat rough; venter crossed by very numerous fine striations.

Limbs rather short, the very broad digits united by a web, almost palmate, the terminal joint of the digits, other than the inner, subtruncate, with terminal joint free and with a small pad present below tip; between toes the web may be slightly excised.

Floor of mouth without a free sublingual fold; choanae very small, their diameter contained in distance between them about six times; paravomerine teeth in a single elongate patch widening gradually posteriorly and notched behind, anteriorly narrow and, save for two or three scattered teeth, widely separated from the vomerine teeth; the vomerine series of about eleven teeth begin beyond the

outer level of the choanae and curve back, separated from each other by a distance equal to twice diameter of choanae; each series arranged partially in two rows; mandibular teeth small, 7-9 almost covered by gums; only a single premaxillary tooth present; 25 mandibular teeth on each side of jaw.

The tail (regenerated) is shorter than head and body, with eighteen caudal grooves present; width of head in head body length, 5.2 times; length of head to gular fold (lateral) in head body length, 3.9 times.

Color: In life nearly uniform slate black above and below; in preserved state the dorsal color is dark brown, the sides slate black, the venter blackish brown; under side of limbs lighter brown; under side of hands and feet grayish white; chin lighter brown than body.

Measurements (in mm.): Total length (tail regenerated), 70; snout to arm, 15; snout to end of vent, 46; axilla to groin, 25; arm, 9.8; leg, 10.1; head width, 8.8; head length to gular fold (lateral), 11.8; head length to gular fold (median), 11.8.

Remarks: Only a single specimen of this species was taken. It was obtained from within the naturally hollow stalk of a large-leafed plant. The entrance had been gained through a hole bored by an insect. It was found nearly a meter below the point of entrance when the stalk was accidentally split.

The curious reduction of the maxillary teeth occurs in no other species of the genus that I have examined and I am uncertain as to its closest relationship.

Bolitoglossa palustris sp. nov.

Type: University of Kansas Museum of Natural History, no. 23817, collected at San Isidro el General, August 23, 1947, by Edward H. Taylor.

Diagnosis: A member of the *rufescens* group, with a short broad head; fully webbed or palmate hand and foot; vomerine teeth 16-18 on strongly elevated ridges, in more than a single series beginning about level of middle of choanae; choanae large; maxillary teeth 14-14; premaxillary teeth 4; no free sublingual fold under tongue; costal grooves indistinct, probably 13; tail much shorter than head and body.

Description of type: Snout moderately short, truncate, moderately elevated above the mouth; subnarial swellings small distinct; nostril small; canthus rostralis rounded, the loreal region sloping abruptly to lip; diameter of eye greater than length of snout,

about equal to its distance from middle of tip; surface of snout on a level with interorbital and occipital surfaces; interorbital width, equal to twice width of eyelid; upper eyelid not overlapping lower behind eye, the ends not fitting in a small groove; no orbitolabial groove; a postorbital groove or depression reaching back to a vertical groove from side of chin which crosses the angle of jaw but fails to reach the top of head, nor is it continuous across chin; a very well-defined gular fold, but grooves from ends of fold not or scarcely traceable on sides of neck, and definitely not reaching to median nuchal line; angle of mouth reaching slightly behind level of orbit; posterior extension of hyoid element forming a very strong fold which reaches back of arm insertion half the length of arm.

Maxillary teeth 14-14 (possibly two or three more as evidenced by breaks in the continuity of the series); 4 premaxillary teeth; vomerine teeth, 16-18; teeth arranged in more than a single irregular row beginning at the level of middle of choanae, and curving slightly, separated from its fellow by a distance equal to greatest diameter of choanae; their diameter contained in distance between them, three and one half times; paravomerine teeth in a single subtriangular patch, the length only about a third greater than width, not notched behind, separated from the vomerine series by a distance greater than half distance between choanae, teeth strong forming typical chevron-shaped series; some pigment evidence in anterior palatal region at side of paravomerine teeth and on floor of mouth anterior to tongue.

Dorsal surface of back rather rough; side and venter smooth; costal grooves not very distinct, apparently 13 present; adpressed limbs separated by 3½ folds; a constriction at base of tail; 25 caudal grooves are present; tail tetragonal in cross section compressed posteriorly, with a subcaudal groove present; anal folds present on sides of cloaca; small glandular area behind insertion of hind limb, dark in color.

Parvimolge richardi sp. nov.

Type: R. C. T.* no. 1436 collected at Isla Bonita (American Cinchona Plantation), Atlantic slope of Volcán Poas at an elevation of about 6,500 feet; Aug. 1, 1947, by Richard Clark Taylor.

Diagnosis: A member of the genus *Parvimolge,* but differing from *Parvimolge townsendi* in the absence of the series of enlarged dorsal glands, but agreeing in the ossification of the skull and the modification of the digits, diminutive body size, moderately enlarged nos-

* Field number of Richard C. Taylor.

tril, presence of maxillary teeth, and absence of an orbito-labial groove.

Snout rather pointed; digits grown together, tips of fingers and toes pointed; tail not constricted at base; chin with an arched groove; nostrils enlarged; thirteen costal grooves; five to six costal folds between adpressed limbs; paravomerine teeth in a single patch, not notched behind; vomerine teeth on strongly elevated ridges; twelve maxillary teeth on each side; six premaxillary teeth.

Description of type: Female; snout bluntly pointed; eye very large, its horizontal diameter a little more than one and two fifths times length of snout; nostril circular, moderately enlarged; interorbital width about equal to an eyelid; surface of head smooth, the openings of skin glands scarcely evident save in a curved series on forehead, between and partly anterior to eyelids.

Gular fold with an irregular groove passing up on each side of head and meeting its fellow on the median line; on chin a groove arching forward (apparently without a groove at base); on each side of the base, a groove passes up across the angle of the jaw to the dorsal surface of the head, then turns diagonally backward and joins its fellow on the mid line somewhat in front of the nuchal groove; a dim groove runs from eye back to the nuchal groove on side of head; thirteen costal grooves; fold caused by the posterior extension of the hyoid cartilage reaching as far as the third costal fold; paravomerine teeth form a single elongate patch, widened and rounded posteriorly, coming nearly to a point anteriorly, separated from vomerine series by a short hiatus; vomerine teeth on two elevated ridges about eight on a side, narrowly separated mesially; maxillary teeth about 12-12 not reaching back as far as the middle of eye; six premaxillary teeth; about 16-16 mandibular teeth.

Adpressed limbs separated by six costal folds. Limbs small, weak, the hands and feet small; digits grown together rather than "webbed." Third finger proportionately very large, the pointed tip extending more than a third of its length beyond other fingers; tip of second finger free, while those of the first and fourth are not or scarcely free. Foot with the first and fifth toes not free; first joint of the second and fourth with terminal joint free; third toe proportionally large, the tip extending beyond other toes for nearly one third of its length.

Sides of the cloaca with smooth diagonal folds.

Color: Above brownish lavender, darker on the head, especially on upper eyelids, dorsally growing lighter to the base of the tail; a

very indefinite darker lateral line; lower part of sides as light or lighter than dorsum; under side of chin and abdomen light purplish with very numerous white or cream flecks; anal region light; tail dark with numerous lighter flecks or vermiculations. The small glandular spot behind insertion of leg scarcely discernible; white flecks below nostril and eye; a white line on tip of snout.

Measurements: Total length, 49.5; snout to vent, 28; snout to foreleg, 7.6; tail, 22; head width, 4.9; length of head to gular fold (ventral), 5; length to gular fold (lateral), 5.85.

Remarks: This specimen was taken near the base of a stump under bark in company with specimens of another undescribed species.

The absence of the enlarged glands on the back show that, while generically related, *parvimolge* and *richardi* are widely distinct specifically. The bluntly pointed snout likewise is a differentiating character easily discerned.

The species is named for Richard Clark Taylor, its discoverer.

Oedipina serpens sp. nov.

Type: University of Kansas Museum of Natural History no. 23815 ♂ ; collected at Morehead Finca, 5 miles southwest of Turrialba, Costa Rica, July 21, 1947, by Edward H. Taylor.

Diagnosis: A very large species of the genus; snout to end of vent, 74.5 mm.; tail more than twice head-body length; width of head in head body length, 9.08 times; head length to gular fold (median), 6.1 times; snout rather elongate, truncate not "sharp"; eye small; snout strongly overhanging lower jaw; digits grown together, free at tip, and rounded; 8-9 costal folds between adpressed limbs.

Description of the type: Snout rather elongate, truncate, the dorsal surface curving without trace of canthus rostralis; median part of snout and interorbital region most elevated; eye very small, its diameter contained in snout length twice, or very slightly less; a small swelling below nostril on lip; posterior part of eyelids not tucked under a diagonal fold; nostrils very small, lunate in shape; width of upper eyelid in smallest interorbital distance, three times.

Gular fold strong, curving forward mesially; from sides of fold a nuchal groove runs up on side of neck but fails to meet its fellow on the middorsal line; a distinct postorbital groove runs back from the eye directed slightly downward, then straight back to beginning of nuchal groove; a groove crosses chin in front of the gular fold, passes behind angle of mouth and reaches to dorsal surface of occi-

put; a short groove about midway between this and the nuchal groove laterally terminating at postorbital groove; only a faint suggestion of an arched groove on chin; no orbitolabial groove; no median dorsal groove; costal grooves nineteen, traceable to midventral line, and to near middle of back; presumably a constriction at base of tail (tail severed); skin very smooth; limbs small, separated by nine costal folds when adpressed; arm adpressed reaches about two thirds distance to eye; fingers broad, grown together rather than "webbed," tips free with indistinct pads below; first finger without free tip, rather well developed; median finger rounded at tip; the other two fingers slightly narrowed at tip; toes very broad, grown together, the tips rounded, terminal joint free on all save inner, with small pads below tips; a white glandular spot behind leg insertion; walls of cloaca with very numerous papillae. Tail (severed and terminal portion missing) thick at base, tapering gradually; 52 + caudal grooves present.

Paravomerine teeth in two series narrowly separated mesially; vomerine teeth in two series, 15-16, which originate much outside outer level of choanae, run straight across mouth for greater part of their length, then curve back, separated from each other by a distance equal to space between four teeth and separated from the paravomerine series by only a slightly greater distance. Choanae small, their length contained in distance between them about five times; three premaxillary teeth piercing gums; maxillary teeth about 50-50; mandibular teeth about 55-55; a strong free sublingual fold.

Posterior extension of hyoid reaches to level of arm insertion.

Color: Dorsal and ventral color, grayish slate (under a lens the circular glands are whitish gray, the intervening space black); spots behind leg insertion bluish white; under surface of limbs somewhat brownish with some small whitish flecks; tip of snout with some indefinite lighter flecks; subnarial swellings and a minute line on edge of upper lip cream; lower eyelid and part of edge of upper whitish; medial area on chin brownish with cream flecks; hands and feet grayish on palms and soles.

Measurements (in mm.): Snout to posterior end of vent, 74.5; snout to arm insertion, 20; axilla to groin, 47; arm, 10; leg, 13.2; head width, 8.8; head length to gular fold (medial), 12; head length to gular fold (lateral), 15; width of body, 9; width of tail base, 7; length of tail, 136 (missing part estimated at about 50 mm.).

Remarks: The specimen was found under a log in rather soft mud

at the edge of a stream bank. It was especially active and elusive and escaped into a pile of large chips from which it was recaptured with considerable effort. The tail was broken and part lost, perhaps by my stepping on chips under which it was moving. Search was made for the lost portion of the tail but it was not found.

Relationship: The relationship apparently is with *Oedipina collaris* Stejneger. The following table of contrasting characters show the major differences between *collaris* and the one here described.

Oedipina collaris	*Oedipina serpens*
1. Snout sharp.	1. Snout blunt, strongly truncate.
2. Head width in head body length, 7.5 times.	2. Head width in head body length, 8.4 times.
3. Head length in head body length, 4.5 times.	3. Head length in head body length, 4.9—6.2 times.*
4. Skin granular.	4. Skin smooth.
5. Vomerine teeth about nine.	5. Vomerine teeth fifteen.
6. Vomerine teeth extend straight across mouth.	6. Vomerine teeth straight for part of series then curving back.
7. Fingers and toes short, scarcely flattened.	7. Fingers and toes long, strongly flattened.
8 Paravomerine (parasphenoid) teeth separated from vomerine teeth by half length of latter series.	8. Paravomerine teeth separated from vomerine teeth by one-third length of one of latter series.
9. Eleven costal folds between adpressed limbs.	9. Nine costal folds between adpressed limbs.
10. Last joint of the third and fourth toes free of membrane.	10. Last joints of second, third and fourth free of membrane.
11. Large dark preocular spot and a narrow black postocular streak.	11. These markings not present.

* The gular fold curves strongly forward on middle of throat; head measured to this point, its length is 12 mm., to the side of head the measurement is 15 mm.

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THE UNIVERSITY OF KANSAS
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Studies on Kansas Mosses I

BY

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University of Kansas, Lawrence

ABSTRACT: Of the total of 167 species and varieties of mosses, which have been reported in the literature from Kansas, 73 are considered doubtful and indeterminable. This leaves 94 collected by the author or represented by specimens in various herbaria. The present paper reports 51 mosses not previously listed for Kansas, giving a total of 145 species and varieties for which collected specimens exist. These species are listed together with their common habitats and the counties from which they have been collected. Much field work and taxonomic study is necessary before our knowledge of the Kansas moss flora becomes complete.

The study of Kansas bryophytes has been almost totally neglected in the past. Except for a brief period of activity between 1884 and 1894 little has been accomplished. During those years several individuals collected and recorded in the literature a considerable number of mosses. Their publications indicate the difficulties they encountered in identifying and naming these plants. As a result, certain of their reported species cannot now be recognized and only a few of their specimens can be found. Errors made by these writers in stating the authority for species increases the doubt as to just what species they may have had.

The most recent paper on Kansas mosses is that of Gier (1949). This paper gives a brief review of Kansas bryological work and reports a few mosses previously unrecorded for the state, but for the most part Gier's list is a compilation from literature. He has revised the nomenclature and has brought it into agreement with that employed by Grout (1928-1940). He brings together previously published lists, but he has not added materially to our knowledge of Kansas mosses.

Attempts at locating specimens from early collections of Kansas mosses have proved almost futile. A small number of specimens were found in the herbarium at Kansas State College, Manhattan, and a few were obtained from Prof. Agrelius of Emporia State Teachers College, Emporia, Kansas. Gier (1949) found some specimens in the Chicago Museum of Natural History and lists a few other herbaria that contain specimens from Kansas. Grout (1928-1940) reported a few specimens, mostly as being in the herbarium of the New York Botanical Garden. It is undoubtedly true that other specimens exist, but such material is unknown to the author.

At the beginning of this work it was apparent that an adequate treatment of the Kansas moss flora would require a fresh start at collecting and naming. With this in mind the author has collected in 82 of the 105 counties in the state. Such collections have, however, been made in conjunction with other field work and have not been made with mosses as the primary item. Thus the several hundred moss collections which form the basis for this paper do not represent a careful survey of the state.

One reason for the neglect of Kansas bryology may have been that the climate of the area would not be expected to favor an extensive moss flora. We find that Renauld and Cardot (1892) referred to Kansas as ". . . an area being in a region of low rainfall, high temperature, nearly treeless, and that frequent, sudden, often severe weather changes occur." This, while only partly true, is still the general opinion in regard to the state. However, the real reason lies in the fact that the systematic botanists of the state have been fully occupied with higher plants, a study that is yet far from being finished.

It is not difficult to find mosses in the state. The eastern half of the state has many limestone and sandstone outcroppings that are usually wooded. In such places one can quickly fill a collecting bag with specimens. The few remaining prairies, particularly the rocky ones in hilly country, yield specimens. Creek banks and other waste areas have their own moss flora. In the western half of the state, rocky hillsides and rock outcroppings yield fewer species, but those present are plentiful. In the same area one finds specimens growing on the open plains, on roadside banks, around springs and ponds and along partially wooded or unwooded stream banks.

In the present paper only those mosses for which known specimens exist will be reported as occurring in the state. All other published records are considered doubtful, since it is impossible to

know whether the plants were correctly named. It is hoped that anyone knowing of unreported species or possessing specimens will bring them to the author's attention. It is also hoped that other workers in the state will collect mosses and either report their findings or send specimens in for determination. Much remains to be done with the Kansas moss flora including the listing of species, their distributions, and with certain species, taxonomic problems that are beyond the scope of this paper.

During the progress of the present work I have drawn freely upon others for assistance. Without their help this study would have been impossible. In this regard I wish to thank Prof. Henry S. Conard of Grinnell, Iowa, for making many determinations and offering information whenever called upon. My thanks also are offered to A. Leroy Andrews, Ithaca, N. Y.; F. C. Gates, Kansas State College, Manhattan; F. U. G. Agrelius, Kansas State Teachers College, Emporia; T. M. Sperry, Kansas State Teachers College, Pittsburg; S. V. Fraser, Aurora, Kansas; W. W. Holland, Walnut, Kansas; W. H. Horr, R. H. Thompson and A. J. Mix of the University of Kansas; and to my wife, Dorothy McGregor, for her valued assistance in collecting and preparing specimens for study and preservation.

In the following list of species definitely known to occur in the state the entries are arranged alphabetically by genera and species following the nomenclature of Grout (1940). With each species is given the habitat and information as to distribution. Unless otherwise indicated all specimens are to be found in the herbarium at the University of Kansas. Those specimens to be found in the herbarium at Kansas State College, Manhattan, Kansas, are designated by (KSC). Those at Kansas State Teachers College, Pittsburg, Kansas, by (KSTCP). The rest are designated fully under the entry.

Amblystegiella confervoides (Brid.) Loeske

On moist limestone rocks. Cherokee Co., McGregor 1942.

Amblystegium americanum Grout

On moist soil near spring on rocky, prairie hillside. Scott Co., McGregor 2159, 2162.

Amblystegium juratzkanum Schimp.

On bark of elm and oak trees, fallen logs. Douglas Co., McGregor 2000; Washington Co., McGregor 2044; Wyandotte Co., M. Reed April 22, 1891 (KSC).

Amblystegium serpens (Hedw.) Bry. Eur.

On rocks and rotten logs. Ellsworth Co., McGregor 1497; Johnson Co., McGregor 2339.

Amblystegium varium (Hedw.) Lindb.

On rocks, soil, logs, bark of trees. Atchison Co., McGregor 1799; Brown Co., McGregor 1050; Butler Co., McGregor 1244, 2249; Chase Co., McGregor 1814; Cherokee Co., McGregor 1942, 2363; Crawford Co., L. J. Gier 721 (KSTCP), McGregor 1763, 1751; Douglas Co., McGregor 2279, 2322; Johnson Co., McGregor 2344, 2388; Marshall Co., McGregor 2027; Miami Co., McGregor 1005, 1039; Morris Co., McGregor 1847; Nemaha Co., McGregor 2007, 2010; Ottawa Co., McGregor 1475; Riley Co., Kellerman May 27, 1887 (KSC); Washington Co., McGregor 2045; Wilson Co., McGregor 2376; Woodson Co., McGregor 2457; Wyandotte Co., McGregor 2423.

Amblystegium varium (Hedw.) Lindb. var. *ovatum* Grout

Moist soil below sandstone outcrop. Ottawa Co., McGregor 1322.

Amblystegium varium (Hedw.) Lindb. var. *parvulum* (Aust.) Grout

Soil at base of tree. Douglas Co., F. U. G. Agrelius, March 1906.

Anomodon attenuatus (Hedw.) Huben.

Soil, rocks, bark of trees. Bourbon Co., McGregor 1776; Cherokee Co., McGregor 1637, 1641; Crawford Co., McGregor 2525; Johnson Co., McGregor 2332, 2333; Wyandotte Co., McGregor 2425.

Anomodon minor (Beauv.) Lindb.

Soil, rocks, bark of trees. Atchison Co., McGregor 1801; Bourbon Co., McGregor 1776, 2517; Douglas Co., McGregor 2280, 2323, 2446; Jefferson Co., McGregor 1409; Johnson Co., McGregor 2329, 2345; Linn Co., McGregor 1957; Lyon Co., McGregor 1593; Riley Co., Kellerman May, 1884 (KSC); Wyandotte Co., McGregor 2424.

Anomodon rostratus Schimp.

On limestone rocks. Bourbon Co., Bennett Nov. 14, 1892 (KSC), McGregor 1776; Johnson Co., McGregor 2329; Miami Co., McGregor 2477; Riley Co., Kellerman April 5, 1888 (KSC).

Aphanorhegma serratum (Hook. and Wils.) Sull.

Moist soil, creek banks. Cherokee Co., McGregor 2559; Decatur Co., McGregor 2104; Douglas Co., McGregor 2463; Leavenworth Co., McGregor 2260; Miami Co., McGregor 2471.

Aschisma kansanum Andrews

This species was described by Andrews (1915) from material collected by E. Hall in western Kansas. The exact location is unknown except that it was collected on the prairies of western Kansas. The type specimen is in the herbarium of the New York Botanical Garden and the Sullivant and James herbarium.

Astomum muhlenbergianum (Sw.) Grout

Soil, wooded hillside. Jackson Co., McGregor 1973

Atrichum angustatum (Brid.) Bry. Eur.

Sandy or rocky soil, roadside banks, woods and thickets. Allen Co., McGregor 1783, 1785; Anderson Co., McGregor 1577, 2497; Atchison Co., McGregor 1804; Chautauqua Co., McGregor 1196; Cherokee Co., McGregor 1020, 1646, 2354; Cloud Co., Fraser Sept. 13, 1948; Crawford Co., Gier 733 (KSTCP),

McGregor 1768, 2527; Douglas Co., McGregor 1045, 1054; Franklin Co., Meeker Nov. 21, 1892, Herrick Nov., 1892 (both specimens in Chicago Natural History Museum); Johnson Co., McGregor 1330; Labette Co., McGregor 1619; Leavenworth Co., McGregor 2269; Miami Co., McGregor 1011; Montgomery Co., McGregor 2388; Ottawa Co., McGregor 1472; Pottawatomie Co., Gates 17288 (KSC), Kellerman June 22, 1888 (KSC), Reed July 7, 1893 (KSC); Riley Co., Kellerman Nov. 5, 1888 (KSC); Saline Co., Henry 1886 (Chicago Natural History Museum); Shawnee Co., McGregor 1229; Wilson Co., McGregor 2380.

Atrichum macmillani (Holz.) Frye

On soil in woods. Crawford Co., W. W. Holland 97 (KSC); Miami Co., McGregor 2592.

Atrichum undulatum (Hedw.) Beauv.

Sandy soil in woods. Washington Co., McGregor 2054.

Atrichum undulatum (Hedw.) Beauv. var. *minus* (Lam. and De Cand.) Web. and Mohr.

Sandy soil below sandstone outcrop. Moist. Washington Co., McGregor 2043.

Atrichum undulatum (Hedw.) Beauv. var. *selwynii* (Aust.) Frye

This variety is included here on the authority of Grout (1928-1940). The county in which it was found is unknown to me though Reed (1894) listed it from Saline County.

Aulacomnium heterostichum (Hedw.) Bry. Eur.

Sandy soil. Oak woods. Woodson Co., McGregor 2456.

Barbula cruegeri Sond.

Limestone rocks, clay soil. Dickinson Co., McGregor 1834; Douglas Co., McGregor 2321; Nemaha Co., McGregor 2014; Republic Co., McGregor 2085.

Barbula fallax Hedw.

Sandy roadside bank. Sumner Co., McGregor 2239.

Barbula unguiculata Hedw.

To be found in nearly any type of habitat. Allen Co., McGregor 2510; Clark Co., McGregor 2208; Clay Co., McGregor 2072; Cloud Co., McGregor 2070; Crawford Co., Gier 724 (KSTCP) McGregor 2526; Decatur Co., McGregor 2133; Dickinson Co., McGregor 1841; Finney Co., McGregor 2181; Hamilton Co., McGregor 2189; Jewell Co., McGregor 2090; Kearny Co., McGregor 2187; Leavenworth Co., McGregor 2267; Marshall Co., McGregor 2038; Nemaha Co., McGregor 2015; Osage Co., McGregor 1574; Phillips Co., McGregor 2100; Pratt Co., McGregor 2217; Rawlins Co., McGregor 2139; Republic Co., McGregor 2086, 2087; Riley Co., Kellerman March 24, 1884 (KSC); Smith Co., McGregor 2093.

Bartramia pomiformis Hedw.

On soil in woods, thickets and along stream banks. Chautauqua Co., McGregor 1193; Cherokee Co., McGregor 1638, 1952; Douglas Co., McGregor 1222; Franklin Co., Herrick Nov., 1892 (KSC); Greenwood Co., McGregor 1911; Jackson Co., McGregor 1976; Linn Co., McGregor 1952.

Brachythecium flexicaule Ren. and Card.

Rocky, sandy soil. Woods and thickets. Cloud Co., Fraser Sept. 13, 1948; Crawford Co., McGregor 1764.

Brachythecium oxycladon (Brid.) Jaeger and Sauerb.

Rocky, sandy soil. Woods and thickets. Anderson Co., McGregor 2497; Bourbon Co., McGregor 2517; Cloud Co., McGregor 2071, Fraser Sept. 13, 1948; Crawford Co., McGregor 2527; Ellsworth Co., McGregor, 1496; Leavenworth Co., McGregor 1392; Miami Co., McGregor 1010; Nemaha Co., McGregor 2004; Republic Co., McGregor 2082; Riley Co., Reed Aug. 12, 1891 (KSC); Sumner Co., McGregor 2237; Wilson Co., McGregor, 2372.

Brachythecium oxycladon (Brid.) Jaeger and Sauerb. var. *dentatum* (Lesq. and James) Grout.

Sandy soil, rocks, base of trees, creek bank. Cherokee Co., McGregor 2351; Crawford Co., McGregor 2525; Doniphan Co., McGregor 1808; Marshall Co., McGregor 2029; Washington Co., McGregor 2040, 2041.

Brachythecium salebrosum (Web. and Mohr.) Bry. Eur.

Sandy soil, rocky wooded hillsides, stream banks. Crawford Co., Gier 728 (KSTCP); Labette Co., McGregor 1618; Mitchell Co., McGregor 1993; Wyandotte Co., Reed May 13, 1891 (KSC).

Bruchia brevifolia Sull.

On exposed, dry, sandy soil. Wilson Co., McGregor 1384.

Bruchia sullivanti Aust.

On sandy soil in oak woods. Chautauqua Co., McGregor 1370; Crawford Co., reported by Gier (1949), specimens in herbarium at William Jewell College, Liberty, Missouri.

Bryum argenteum (L.) Hedw.

Occurs on a wide range of habitats from soil in swamps, to open places in prairie and on rock outcrops. Anderson Co., Thompson Feb. 2, 1948; Cheyenne Co., McGregor 2145; Crawford Co., reported by Gier (1949); Doniphan Co., McGregor 1966; Douglas Co., McGregor 2454; Kearny Co., McGregor 2186, 2187; Kingman Co., McGregor 2227; Labette Co., McGregor 1608, 1609; Leavenworth Co., McGregor 1387; Lincoln Co., McGregor 1985; Lyon Co., Agrelius May 30, 1912, McGregor 1589; Morris Co., McGregor 1849; Neosho Co., Holland 94 (KSC); Ottawa Co., McGregor 1317; Pratt Co., McGregor 2218; Reno Co., Voth Aug. 22, 1944 (in Herbarium Chicago Museum Natural History); Saline Co., McGregor 1485; Washington Co., McGregor 2060, 2062; Wabaunsee Co., McGregor 1856; Wilson Co., reported by L. J. Gier (1949), specimen in herbarium William Jewell College, Liberty, Missouri.

Bryum argenteum (L.) Hedw. var. *lanatum* (Beauv.) Bry. Eur.

Rocky hillsides and open places in prairie. Anderson Co., Thompson Feb. 2, 1948; Clay Co., McGregor 2074; Jefferson Co., McGregor 1412; Kingman Co., McGregor 2220.

Bryum bicolor Dicks.

On rocks, sandy banks, creek banks, open places in prairie. Chase Co., McGregor 1810; Cloud Co., McGregor 2064; Decatur Co., McGregor 2105;

Dickinson Co., McGregor 1835; Harper Co., McGregor 2235; Pratt Co., McGregor 2217; Rawlins Co., McGregor 2137, 2139; Reno Co., Voth Aug. 22, 1944, reported by Gier (1949); Republic Co., McGregor 2086; Wabaunsee Co., McGregor 1855.

Bryum caespiticium (L.) Hedw.

On sandstone and limestone rocks, rocky soil, creek banks, open places in prairie, sagebrush flats and roadside banks. Barber Co., W. H. Horr 3114; Barton Co., McGregor 1304, 1305; Cherokee Co., McGregor 1026; Clark Co., McGregor 2210; Crawford Co., Holland 92 (KSC); Decatur Co., McGregor 2103, 2133; Douglas Co., McGregor 1034, 2454; Grant Co., W. H. Horr 3081; Harper Co., McGregor 2235; Leavenworth Co., McGregor 1391; Lincoln Co., McGregor 1984; Lyon Co., McGregor 1590; Marion Co., McGregor 1817; Meade Co., McGregor 2201; Montgomery Co., McGregor 1176; Nemaha Co., McGregor 2003; Phillips Co., McGregor 2099; Pratt Co., McGregor 2218; Republic Co., McGregor 1326; Washington Co., McGregor 2050, 2060; Wyandotte Co., Reed May 5, 1892 (KSC).

Bryum cuspidatum (Bry. Eur.) Schimp.

On limestone and sandstone rocks; on soils in woods, prairie, stream banks and swampy areas. Butler Co., McGregor 2248; Dickinson Co., McGregor 1834, 1842; Douglas Co., McGregor 1041; Marshall Co., McGregor 2034; Nemaha Co., McGregor 2006, 2009; Rawlins Co., McGregor 2140; Republic Co., McGregor 2084, 2087; Scott Co., McGregor 2177; Washington Co., McGregor 2049.

Bryum gemmiparum DeNot.

On moist soil and rocks below a spring. Scott Co., McGregor 2161.

Bryum pendulum (Hornsch.) Schimp.

Sandstone rocks and sandy soil. Ellsworth Co., McGregor 1505, 1508; Saline Co., McGregor 1483, 1494.

Bryum pseudotriquetrum (Hedw.) Schwaegr.

On logs, sandstone and limestone rocks, soil in woods. Cherokee Co., McGregor 2362; Crawford Co., 1765, 1766; Miami Co., McGregor 1010; Nemaha Co., McGregor 2008; Wilson Co., McGregor 2373.

Campylium chrysophyllum (Brid.) Bryhn.

On soil in woods, below rock outcrops, roadside banks and occasionally at base of grasses in prairie. Atchison Co., McGregor 1802, 1804; Cherokee Co., McGregor 1020, 1025, 1644; Clay Co., McGregor 2075; Cloud Co., McGregor 2068; Crawford Co., Gier 727 (KSTCP); Doniphan Co., McGregor 1808; Douglas Co., McGregor 2301; Leavenworth Co., McGregor 1436, 1437; Miami Co., McGregor 1008, 1011; Republic Co., McGregor 2078, 2081; Riley Co., Kellerman May 27, 1887 (KSC); Washington Co., McGregor 2042.

Campylium chrysophyllum (Brid.) Bryhn var. *brevifolium* (Ren. and Card.) Grout.

On rocky or sandy soil. Cherokee Co., McGregor 1764; Ellsworth Co., McGregor 1496, 1498; Leavenworth Co., McGregor 1395; Montgomery Co., McGregor 1178; Ottawa Co., McGregor 1469; Saline Co., McGregor 1491.

Campylium hispidulum (Brid.) Mitt.

Tree bark, sandy soil, stream banks. Cherokee Co., McGregor 1021, 1023, 1027, 1643; Crawford Co., Gier 723 (KSTCP), McGregor 1752, 1756, 1763; Douglas Co., McGregor 1040; Leavenworth Co., McGregor 1398, 1399; Republic Co., McGregor 2081a; Riley Co., Reed June 30, 1892 (KSC).

Ceratodon purpureus (Hedw.) Brid.

On sandstone rocks, sandy soil, rocky soil in woods, roadside banks and around base of grasses in prairie. Brown Co., McGregor 1049; Clark Co., McGregor 2209; Cloud Co., McGregor 2064; Cowley Co., W. H. Horr 3168; Crawford Co., McGregor 1767; Douglas Co., Agrelius May 1, 1906; Ellsworth Co., McGregor 1510; Leavenworth Co., McGregor 1391, 1394; Lyon Co., McGregor 1590; Nemaha Co., McGregor 2005; Ottawa Co., McGregor 1317; Rawlins Co., McGregor 2138; Republic Co., McGregor 1326, 1327; Riley Co., Reed Aug. 12, 1891 (KSC); Saline Co., McGregor 1481; Shawnee Co., McGregor 1228; Wyandotte Co., Reed May 5, 1891 (KSC).

Chamberlainia acuminata (Hedw.) Grout.

On limestone rocks, tree bark, and soil at base of trees. Anderson Co., McGregor 2493; Douglas Co., McGregor 2274; Johnson Co., McGregor 2343; Marshall Co., McGregor 2028; Mitchell Co., McGregor 1998; Morris Co., McGregor 1846; Pottawatomie Co., Reed Nov. 6, 1892 (KSC); Reno Co., McGregor 2225; Republic Co., McGregor 2083.

Climacium americanum Brid.

Sandstone rocks and soil in oak woods. Elk Co., McGregor 1923; Greenwood Co., McGregor 1902.

Cratoneuron filicinum (Hedw.) Roth.

On soil among rushes and sedges in marsh. Atchison Co., McGregor 1017.

Desmotodon obtusifolius (Schwaegr.) Jur.

Predominantly on sandstone rock, rarely on limestone. Occasionally on sandy alluvial soil. Allen Co., McGregor 1788; Barton Co., McGregor 1304, 1305; Chase Co., McGregor 1812; Cheyenne Co., McGregor 2145; Crawford Co., Holland 90 (Collector's herbarium); Douglas Co., McGregor 1043; Ellsworth Co., McGregor 1511; Leavenworth Co., McGregor 1387, 2260; McPherson Co., McGregor 1820; Neosho Co., McGregor 1256; Ottawa Co., McGregor 1317; Rawlins Co., McGregor 2135; Rice Co., McGregor 1831; Saline Co., McGregor 1487; Washington Co., McGregor 2058, 2061; Wilson Co., McGregor 2381.

Desmatodon plinthobius Sull. and Lesq.

On sandstone and limestone rocks and soil near such rocks. Butler Co., McGregor 2244a; Chase Co., McGregor 1813; Dickinson Co., McGregor 1839; Harper Co., McGregor 2232; Ottawa Co., McGregor 1318.

Desmatodon porteri James.

On limestone rocks. Atchison Co., McGregor 1796.

Dicranella heteromalla (Hedw.) Schimp.

On soil in woods. Occasionally on rocks. Allen Co., McGregor 1784; Crawford Co., McGregor 1761; Douglas Co., McGregor 2302; Elk Co., Mc-

Gregor 1921; Greenwood Co., McGregor 1904; Leavenworth Co., McGregor 1390, 2266; Montgomery Co., McGregor 2391.

Dicranella varia (Hedw.) Schimp.

On rocks, sandy alluvial soil. Allen Co., McGregor 2508; Anderson Co., McGregor 2490; Crawford Co., McGregor 2528; Douglas Co., McGregor 2306; Leavenworth Co., McGregor 2263; Washington Co., McGregor 2052.

Dicranum condensatum Hedw.

Sandy soil in oak woods. Chautauqua Co., McGregor 1201; Elk Co., McGregor 1918; Montgomery Co., McGregor 1173.

Dicranum scoparium Hedw.

Moist soil in woods. Chautauqua Co., McGregor 1201; Cherokee Co., McGregor 1018, 1944; Doniphan Co., McGregor 1971; Jackson Co., McGregor 1980; Leavenworth Co., McGregor 1390, 1432, 2259, 2261; Linn Co., McGregor 1953; Montgomery Co., McGregor 1173.

Didymodon rigidulus Hedw.

On rocky soil. Logan Co., McGregor 2156.

Didymodon tophaceus (Brid.) Jur.

On soil near a spring in prairie. Scott Co., McGregor 2158, 2160.

Didymodon trifarius (Hedw.) Brid.

This species is incuded here on the authority of Gier (1949) and a personal letter from Prof. Gier. He found a specimen of this species in the Chicago Natural History Museum collected by W. R. Maxon in April, 1912. The locality was not given on the label except for the name of the state.

Ditrichum pallidum (Hedw.) Hampe.

Moist soil in woods. Occasionally found among rocks in prairies of central Kansas. Anderson Co., McGregor 1578; Chautauqua Co., McGregor 1190; Cherokee Co., McGregor 1029, 1031; Crawford Co., Holland 91 (KSC); Douglas Co., McGregor 1045; Franklin Co., McGregor 1341; Labette Co., McGregor 1606; Leavenworth Co., McGregor 1437; Lincoln Co., McGregor 1982; Miami Co., McGregor 1008; Ottawa Co., McGregor 1324; Wilson Co., McGregor 1385, 2380, McClung May 9, 1891 (KSC); Woodson Co., McGregor 1253.

Drepanocladus aduncus (Hedw.) Warnst. var. *kneiffi* (Bry. Eur.) Warnst.

On soil. Crawford Co., Gier 725 (KSTCP).

Drepanocladus aduncus (Hedw.) Warnst. var. *polycarpus* (Bland.) Warnst.

Very moist sandy soil. Mitchell Co., McGregor 1997; Trego Co., Reed July 8, 1893 (KSC).

Drummondia prorepens (Hedw.) Jennings.

On tree bark and limestone rocks. Cherokee Co., McGregor 1649, 1931.

Entodon cladorrhizans (Hedw.) C. Muell.

On limestone rocks. Johnson Co., McGregor 2332.

Entodon compressus (Hedw.) C. Muell.

On logs, bark of trees and moist soil. Bourbon Co., McGregor 2518; Butler

Co., McGregor 2250; Douglas Co., McGregor 2309, 2318; Johnson Co., McGregor 2335, 2337; Marshall Co., McGregor 2025; Morris Co., McGregor 1845; Nemaha Co., McGregor 2021; Ottawa Co., McGregor 1475; Washington Co., McGregor 2053.

Entodon seductrix (Hedw.) C. Muell.

On limestone and sandstone rocks, fallen logs, base of trees and moist soil in woods. Allen Co., McGregor 1786, 2505; Anderson Co., McGregor 1964, 2492; Bourbon Co., McGregor 1769; Chautauqua Co., McGregor 1199; Cherokee Co., McGregor 1941; Crawford Co., Holland 95 (KSC), Gier 718 (KSTCP), McGregor 1762; Douglas Co., Agrelius Nov. 3, 1906 and April 28, 1906, Thompson March 14, 1948, McGregor 1055, 2278, 2281; Jefferson Co., McGregor 1411; Labette Co., McGregor 1621; Leavenworth Co., McGregor 1393, 2258, 2265; Lincoln Co., McGregor 1986; Linn Co., McGregor 1955; Miami Co., McGregor 1053, 2476; Saline Co., McGregor 1490; Wilson Co., McGregor 2375.

Eucladium verticillatum (Brid.) Bry. Eur.

Very moist limestone rocks. Cherokee Co., McGregor 1625.

Eurhynchium hians (Hedw.) Jaeger and Sauerb.

On rocks, logs, soil and bark of trees. Cherokee Co., McGregor 1025, 1632; Dickinson Co., McGregor 1840; Douglas Co., McGregor 2317; Johnson Co., McGregor 2336; Leavenworth Co., McGregor 1395, 1398; Miami Co., McGregor 1013; Nemaha Co., McGregor 2012; Shawnee Co., L. D. Volle Oct. 1, 1948; Wabaunsee Co., McGregor 1854; Wyandotte Co., Reed May 1, 1891 (KSC).

Eurhynchium serrulatum (Hedw.) Kindb.

Moist soil in woods. On logs and bark of trees. Cherokee Co., McGregor 1021; Crawford Co., Gier 722 (KSTCP), McGregor 1755, 1758; Douglas Co., Agrelius March, 1906, McGregor 1048, 2277, 2304; Johnson Co., McGregor 2343; Wyandotte Co., McGregor 2422, 2424.

Fabronia wrightii Sull.

Bark of elm trees. Crawford Co., McGregor 1759; Dickinson Co., McGregor 1843; Douglas Co., McGregor 2281; Harvey Co., McGregor 2253; Marshall Co., McGregor 2022.

Fissidens bushii Card. and Ther.

On soil in rocky wooded hillside. Anderson Co., McGregor 2495.

Fissidens cristatus Wils.

Moist limestone rocks. Cherokee Co., McGregor 1635.

Fissidens cristatus Wils. var. *winonensis* (Ren. and Card.) Grout.

Moist sandy soil in oak woods. Greenwood Co., McGregor 1903.

Fissidens julianus (Mont.) Schimp.

Attached to rocks, sticks and other submerged objects in clear, slow-moving streams. Cherokee Co., McGregor 2361; Woodson Co., McGregor 2459.

Fissidens minutulus Sull.

Moist sandstone and limestone rocks. Also moist sandy banks. Atchison

Co., McGregor 1799; Cherokee Co., McGregor 1943; Franklin Co., McGregor 1515; Leavenworth Co., McGregor 2264; Republic Co., McGregor 2080; Wilson Co., McGregor 2376, 2384.

Fissidens obtusifolius Wils.

Moist sandstone and limestone rocks. Chase Co., McGregor 1812; Leavenworth Co., McGregor 1579, 2260, 2264; Washington Co., McGregor 2056, 2058.

Fissidens obtusifolius Wils. var. *kansanus* Ren. and Card.

This variety was described by Renauld and Cardot (1890) from material sent them by Dr. Joseph Henry of Salina, Kansas. This fact was mentioned by Grout (1928-1940). I have not checked on the location of the type herbarium specimens. The type locality is Saline County.

Fissidens subbasilaris Hedw.

On moist limestone rocks. Cherokee Co., McGregor 1941; Douglas Co., McGregor 2307; Johnson Co., McGregor 2340.

Fissidens taxifolius Hedw.

This species was reported from Crawford County Kansas State Park by Gier (1940, 1949). I have seen a packet of his material on file in the herbarium of Kansas State Teachers College, Pittsburg, Kansas.

Fontinalis missourica Card.

Gier (1949) and in personal correspondence with me says there is a packet of this species in the herbarium of the Chicago Museum of Natural History. The specimen was collected by E. Hall in 1870. According to Gier (1949) the locality was given as "headwaters of the Neosho River." This would seem to place the actual location of the collection to the northwest of Greenwood County. Gier (1949) mentioned Greenwood County as a possible location.

Funaria calvescens Schwaegr.

Sandy soil. Wilson Co., McGregor 1276.

Funaria flavicans Mx.

Moist soil in woods. Chautauqua Co., McGregor 1191; Douglas Co., McGregor 1033; Jefferson Co., McGregor 1414; Johnson Co., McGregor 1333; Woodson Co., McGregor 1252.

Funaria hygrometrica Hedw.

Open places in woods especially recently burned over areas, roadside banks, creek banks and abandoned fields. Also open places in prairie. Brown Co., McGregor 1049; Cherokee Co., McGregor 1022; Crawford Co., Gier 729 (KSTCP), Holland 99 (KSC), McGregor 1832; Douglas Co., McGregor 1044, 1421; Dickinson Co., McGregor 1837; Ellsworth Co., McGregor 1507; Finney Co., McGregor 2182; Hamilton Co., McGregor 2189; Labette Co., McGregor 1609, 1610; Lyon Co., Agrelius June 29, 1912; McPherson Co., McGregor 1821; Morris Co., McGregor 1849; Ottawa Co., McGregor 1323, 1324; Pottawatomie Co., Reed July 7, 1893 (KSC); Rice Co., McGregor 1824, 1832; Riley Co., Norton 1893 (KSC); Saline Co., McGregor 1493; Washington Co., McGregor 2056; Woodson Co., McGregor 1793; Wyandotte Co., Reed April and May 1891 (KSC).

Grimmia alpicola Hedw.

On limestone rocks. Bourbon Co., McGregor 1770.

Grimmia apocarpa Hedw.

On dry exposed limestone and sandstone rocks. Anderson Co., Thompson Feb. 2, 1948; Chautauqua Co., McGregor 1194; Clark Co., McGregor 2210; Cowley Co., McGregor 2241; Lyon Co., McGregor 1594; Marshall Co., McGregor 2026; Mitchell Co., McGregor 1996; Scott Co., McGregor 2176; Wyandotte Co., Reed July 24, 1893 (KSC).

Grimmia laevigata (Brid.) Brid.

Dry exposed sandstone rocks. Chautauqua Co., McGregor 1192, 1197; Douglas Co., McGregor 2314; Saline Co., McGregor 1492; Wilson Co., McGregor 2371.

Grimmia plagiopodia Hedw.

Dry rocks. Rice Co., McGregor 1825.

Grimmia raui Aust.

Found abundantly on a rock outcrop in western Kansas known commonly as the mortar beds. Clark Co., McGregor 2207; Decatur Co., McGregor 2132; Kearny Co., McGregor 2185; Logan Co., McGregor 2152, 2155; Meade Co., McGregor 2206; Rawlins Co., McGregor 2134; Scott Co., McGregor 2175.

Gymnostomum recurvirostrum Hedw.

On moist, rocky soil in woods. Cherokee Co., McGregor 2366.

Hedwigia ciliata Hedw.

On sandy soil and sandstone rocks. Allen Co., McGregor 1782; Chautauqua Co., McGregor 1198; Doniphan Co., McGregor 1968; Douglas Co., McGregor 2315; Greenwood Co., McGregor 1910; Wilson Co., McGregor 2374, 2378.

Homomallium adnatum (Hedw.) Broth.

Limestone and sandstone rocks. Tree bark. On soil in woods and roadside banks. Allen Co., McGregor 1790; Bourbon Co., McGregor 2520; Cherokee Co., McGregor 1019, 1636; Crawford Co., Holland 89 (KSC); Johnson Co., McGregor 2345, 2346; Labette Co., McGregor 1605, 1611; Lincoln Co., McGregor 1983; Montgomery Co., McGregor 1174; Morris Co., McGregor 1851; Wilson Co., McGregor 1383.

Hygroamblystegium irriguum (Wils.) Loeske.

On logs, base of trees, sandstone and limestone rocks, moist soil in woods. Allen Co., McGregor 1791; Anderson Co., McGregor 1962; Cherokee Co., McGregor 1030, 1926, 1929; Doniphan Co., McGregor 1970; Douglas Co., Agrelius Feb. 22, 1906, McGregor 1036, 1422, 1630, 2276; Ellsworth Co., McGregor 1509; Leavenworth Co., McGregor 1392, 1434; Miami Co., McGregor 1012, 1929; Rice Co., McGregor 1829; Riley Co., Swingle May 1890 (KSC), Kellerman May 6, 1887 (KSC); Saline Co., McGregor 1495; Scott Co., McGregor 2163, 2164; Wilson Co., McGregor 2384; Woodson Co., McGregor 1250; Wyandotte Co., McGregor 2429.

Hygroamblystegium orthocladon (Beauv.) Grout.

On sandstone rock and calcareous soil. Leavenworth Co., McGregor 1386; Morris Co., McGregor 1848.

Hypnum curvifolium Hedw.

On soil, wooded hillside. Jackson Co., McGregor 1979.

Hypnum patientiae Lindb.

Limestone rocks and soil in woods. Cherokee Co., McGregor 1626, 2263, 2364; Jackson Co., McGregor 1978.

Leptobryum pyriforme (Hedw.) Schimp.

On sandstone and limestone rocks. McPherson Co., McGregor 1821; Nemaha Co., McGregor 2002; Pottawatomie Co., Reed July 7, 1893 (KSC).

Leptodictyum riparium (Hedw.) Warnst.

Rotten logs, moist soil in woods, base of cattails and sedges in swamps. Atchison Co., McGregor 1016; Brown Co., McGregor 1051; Cherokee Co., McGregor 1631; Crawford Co., Gier 726 (KSTCP); Douglas Co., McGregor 2308; Ellsworth Co., McGregor 1310; Jefferson Co., McGregor 1417; Meade Co., McGregor 1302; Miami Co., McGregor 1039, 2479.

Leptodictyum trichopodium (Schultz) Warnst.

Moist soil especially in seepy areas or swamps. Atchison Co., McGregor 1015; Douglas Co., McGregor 1034, 2278; Ellsworth Co., McGregor 1507; Leavenworth Co., McGregor 1393; Meade Co., McGregor 1302, 2198, W. H. Horr 3110; Ottawa Co., McGregor 1325, 1473; Rice Co., McGregor 1827; Saline Co., McGregor 1482, 1489; Woodson Co., McGregor 2457.

Leptodictyum trichopodium (Schultz) Warnst. var. *kochii* (Bry. Eur.) Broth.

On moist sandy soil. Dickinson Co., McGregor 1834; Douglas Co., McGregor 1224.

Leskea gracilescens Hedw.

Bark of trees, rotten logs, rarely on soil in woods. Allen Co., McGregor 2509; Anderson Co., McGregor 2493; Bourbon Co., McGregor 1771; Butler Co., McGregor 2250; Cherokee Co., McGregor 1634, 1639; Cloud Co., McGregor 2063, 2066; Coffey Co., McGregor 1599; Comanche Co., W. H. Horr 3116; Crawford Co., Gier 719 (KSTCP); Dickinson Co., McGregor 1833; Douglas Co., McGregor 2309; Franklin Co., McGregor 1575; Harvey Co., McGregor 2252; Jefferson Co., McGregor 1410; Jewell Co., McGregor 2088; Johnson Co., McGregor 2331; Leavenworth Co., McGregor 1388; Linn Co., McGregor 1958; Lyon Co., McGregor 1595; Marion Co., McGregor 1816; Marshall Co., McGregor 2024; McPherson Co., McGregor 1818; Miami Co., McGregor 2465; Morris Co., McGregor 1850; Nemaha Co., McGregor 2010; Osage Co., McGregor 1571; Reno Co., McGregor 2224; Republic Co., McGregor 2077; Sumner Co., McGregor 2238; Washington Co., McGregor 2059; Wabaunsee Co., McGregor 1852; Wyandotte Co., Reed April 2, 1891 (KSC), McGregor 2424.

Leskea obscura Hedw.

On bark of elms, oaks and logs. Allen Co., McGregor 2509; Atchison Co., McGregor 1799; Coffey Co., McGregor 1600; Crawford Co., McGregor 1757; Douglas Co., McGregor 1224, Agrelius, May 1, 1906; Geary Co., F. C. Gates 18890 (KSC); Labette Co., McGregor 1613; Lincoln Co., McGregor 1989; Miami Co., McGregor 1006; Mitchell Co., McGregor 1990; Nemaha Co.,

McGregor 2005; Pottawatomie Co., Reed Nov. 6, 1891 (KSC), Reed Nov. 26, 1892 (KSC).

Leucobryum albidum (Brid.) Lindb.

On sandy soil, oak woods. Chautauqua Co., McGregor 1201.

Leucobryum glaucum (Hedw.) Schimp.

On sandy soil, oak woods. Anderson Co., McGregor 2496; Cherokee Co., McGregor 1647; Crawford Co., McGregor 2524; Elk Co., McGregor 1922; Greenwood Co., McGregor 1906; Jackson Co., McGregor 1974; Montgomery Co., McGregor 2387.

Leucodon brachypus Brid.

Credited to Kansas by Grout (1928-1940). I do not know location of specimen or locality from which collected.

Leucodon julaceous (Hedw.) Sull.

Moist limestone rocks. Anderson Co., McGregor 2498; Allen Co., McGregor 2506; Cherokee Co., McGregor 1653.

Lindbergia brachyptera (Mitt.) Kindb. var. *austinii* (Sull.) Grout.

This variety is reported from Kansas by Grout (1928-1940). I do not know locality from which collected or location of specimen. Reed (1894) reported it from Saline County.

Mnium affine Bland.

Moist clay creek bank. Douglas Co., McGregor 2305.

Mnium cuspidatum Hedw.

On sandstone and limestone rocks, soil in woods, creek banks, fields, base of trees and tree bark. Allen Co., McGregor 1787; Anderson Co., McGregor 1577; Atchison Co., McGregor 1804, 1797; Bourbon Co., McGregor 1773; Chautauqua Co., McGregor 1200; Cherokee Co., McGregor 1028, 1650; Crawford Co., Holland 87 (KSC), Gier 734 (KSTCP), McGregor 1752; Douglas Co., McGregor 1047, Agrelius May 1, 1910, Thompson March 14, 1948; Ellsworth Co., McGregor 1503; Jefferson Co., McGregor 1416, 1418; Johnson Co., McGregor 1332, 2344; Labette Co., McGregor 1617; Leavenworth Co., McGregor 1396; Lincoln Co., McGregor 1981; McPherson Co., McGregor 1823; Miami Co., McGregor 1013; Nemaha Co., McGregor 2011; Ottawa Co., McGregor 1476; Rice Co., McGregor 1827; Riley Co., Kellerman May 25, 1887 (KSC), Jones May 18, 1892 (KSC); Saline Co., McGregor 1486; Shawnee Co., McGregor 1227, L. D. Volle Oct. 1, 1948; Washington Co., McGregor 2039; Wabaunsee Co., McGregor 1853; Woodson Co., McGregor 1251; Wyandotte Co., McGregor 2426.

Orthotrichum diaphanum Brid.

Bark of elm trees. Reno Co., McGregor 2223.

Orthotrichum pumilum Dicks.

Bark of elm, hackberry and oak. Cherokee Co., McGregor 1021, 1627, 1634; Cloud Co., McGregor 2069; Crawford Co., McGregor 1754, 1759; Dickinson Co., McGregor 1844; Doniphan Co., McGregor 1967; Douglas Co., McGregor 2621; Marshall Co., McGregor 2023; Washington Co., McGregor 2059.

Orthotrichum pusillum Mitt.

Bark of elm and oak. Cherokee Co., McGregor 1627; Labette Co., McGregor 1607; Reno Co., Voth Aug. 1944, specimen in herbarium at Chicago Natural History Museum according to Gier (1949).

Orthotrichum sordidum Lesq. and James.

Tree bark. Crawford Co., Holland 93 (KSC).

Orthotrichum strangulatum Schwaegr.

On limestone and sandstone rocks. Cherokee Co., McGregor 1640; Mitchell Co., McGregor 1994; Riley Co., Kellerman May 4, 1884 (KSC).

Phascum cuspidatum Hedw. var. *americanum* Ren. and Card.

On sandy soil, oak woods. Shawnee Co., McGregor 1230.

Philonotis glaucescens (Hornsch.) Paris.

This species reported by Grout (1928-1940). I do not know location of specimen or locality from which collected.

Philonotis gracillima Angstr.

This species was reported by Grout (1928-1940). I do not know location of specimen or locality from which collected.

Philonotis marchica (Willd.) Brid.

Moist sandy soil in woods. Cherokee Co., McGregor 2365; Montgomery Co., McGregor 2388.

Physcomitrium hookeri Hampe.

On moist soil, edge of swamp. Meade Co., McGregor 1313.

Physcomitrium kellermani E. G. Britton.

Sandy soil, creek banks and open places in prairie. Cowley Co., McGregor 2243; Douglas Co., McGregor 1223; Kingman Co., McGregor 2228; Norton Co., McGregor 2101; Riley Co., Kellerman 1889 (this is the type specimen on file in herb. N. Y. Botanical Garden); Rook Co., McGregor 2096.

Physcomitrium turbinatum (Mx.) Brid.

Moist sandy soil, creek banks, seepy or swampy areas, moist fields. Chautauqua Co., McGregor 1371; Crawford Co., Holland 88, 101 (KSC), Gier 731 (KSTCP); Douglas Co., McGregor 1035, 1042, 1423, Agrelius April 20, 1906; Ellsworth Co., McGregor 1504, 1506; Franklin Co., McGregor 1340; Jefferson Co., McGregor 1414; Johnson Co., McGregor 1331; Labette Co., McGregor 1615; Leavenworth Co., McGregor 1615; Lincoln Co., McGregor 1987; Mitchell Co., McGregor 1991; Osage Co., McGregor, 1573; Ottawa Co., McGregor 1470; Saline Co., McGregor 1484, 1489; Sedgwick Co., Carleton 131 (KSC); Wyandotte Co., Reed May 5, 1891 (KSC), McGregor 1443.

Plagiothecium deplanatum (Sull.) Grout.

Moist soil, wooded hillside. Wyandotte Co., McGregor 2421.

Plagiothecium geophilum (Aust.) Grout.

Bark of elm. Atchison Co., McGregor 1800; Miami Co., McGregor 1012; Wyandotte Co., McGregor 2422, 2424.

Platygyrium repens (Brid.) Bry. Eur.

Sandstone rocks, logs, tree bark. Bourbon Co., McGregor 1772; Cherokee Co., McGregor 1627, 2352; Jackson Co., McGregor 1977; Johnson Co., McGregor 2341; Leavenworth Co., McGregor 2268; Mitchell Co., McGregor 1998; Pottawatomie Co., Reed Nov. 6, 1892 (KSC).

Pleuridium subulatum (Hedw.) Lindb.

Sandy soil, woods, prairie. Johnson Co., McGregor 1334; Leavenworth Co., McGregor 1430; Washington Co., McGregor 2048.

Pleuridium sullivanti Aust.

Dry sandy soil in prairie. Woodson Co., McGregor 1249.

Pogonatum brachyphyllum (Rich.) Beauv.

Sandy soil in woods. Douglas Co., McGregor 1052; Neosho Co., Thompson March 6, 1949; Wilson Co., McGregor 2383; Woodson Co., McGregor 2636.

Pohlia nutans (Hedw.) Lindb.

On sandstone rocks, sandy soil in woods. Allen Co., McGregor 1784; Cherokee Co., McGregor 1646; Crawford Co., McGregor 1761; Douglas Co., Agrelius April 4, 1910; Leavenworth Co., McGregor 1390, 1435, 2261; Miami Co., McGregor 1009; Pottawatomie Co., Reed July 7, 1893 (KSC); Wilson Co., McGregor 2382.

Pohlia wahlenbergii (Webr. and Mohr.) Andrews.

Sandstone rocks, sandy soil, moist soil in woods. Douglas Co., McGregor 2273; Leavenworth Co., McGregor 2267; Mitchell Co., McGregor 1995; Ottawa Co., McGregor 1474; Riley Co., Reed April 7, 1893 (KSC); Saline Co., Hancin 1320 (KSC), McGregor 1482; Washington Co., McGregor 2051; Woodson Co., McGregor 2458.

Polytrichum commune Hedw.

Sandy soil in oak woods. Elk Co., McGregor 1919; Greenwood Co., McGregor 1905, 1909.

Polytrichum juniperinum Hedw.

Rocky or sandy soil in woods. Chautauqua Co., McGregor 1189; Cherokee Co., McGregor 1018, 1024; Doniphan Co., McGregor 1969; Elk Co., McGregor 1914; Leavenworth Co., McGregor 1431; Montgomery Co., McGregor 1172; Pottawatomie Co., Reed July 7, 1893 (KSC).

Polytrichum ohioense Ren. and Card.

Rocky or sandy soil in woods. Cherokee Co., McGregor 1651; Douglas Co., McGregor 1014.

Pterigoneurum subsessile (Brid.) Jur.

Open places in rocky prairie. Rawlins Co., McGregor 2141.

Pterigoneurum subsessile (Brid.) Jur. var. *henrici* (Rau) Wareham.

The type material, according to Grout (1928-1940), is in the herbarium of the New York Botanical Garden and was collected by Joseph Henry in Saline County.

Ptychomitrium incurvum (Muhlenb.) Sull.

On sandstone rocks. Montgomery Co., McGregor 1174, 1179.

Pylaisia selwynii Kindb.

Bark of elm trees. Anderson Co., McGregor 1963; Linn Co., McGregor 1951; Mitchell Co., McGregor 1992; Riley Co., Kellerman May 1884 (KSC).

Pyramidula tetragona (Brid.) Brid.

Sandy soil in prairie. Douglas Co., McGregor Nov. 2, 1947.

Rhodobryum roseum (Bry. Eur.) Limpr.

On soil in woods. Jackson Co., McGregor 1975.

Sematophyllum carolinianum (C. Mull.) E. G. Britton.

On sandstone rocks. Montgomery Co., McGregor 2390.

Sphagnum capillaceum (Weiss) Schrank

Moist sandy soil on bank of small creek. Woodson Co., Thompson Sept. 1945, McGregor 2647.

Thelia asprella Sull.

Limestone rocks, moist soil, bark of elm. Cherokee Co., McGregor 1945; Douglas Co., McGregor 2445; Greenwood Co., E. Hall (in herbarium at Chicago Museum of Natural History according to a personal letter received from L. J. Gier of Liberty, Missouri); Johnson Co., McGregor 2331; Linn Co., McGregor 1956.

Thelia hirtella (Hedw.) Sull.

On limestone rocks. Allen Co., McGregor 2507; Anderson Co., McGregor 2494.

Thelia lescurii Sull.

On moist limestone rocks. Cherokee Co., McGregor 1652, 1654; Douglas Co., Agrelius Nov. 3, 1906.

Thuidium delicatulum (Hedw.) Mitt.

Moist limestone rocks, sandy soil, moist soil in woods. Cherokee Co., McGregor 1642; Elk Co., McGregor 1920; Greenwood Co., McGregor 1901.

Thuidium microphyllum (Hedw.) Best.

Bark of elm. Cherokee Co., McGregor 1021; Crawford Co., Gier 720 (KSTCP).

Thuidium recognitum (Hedw.) Lindb.

On limestone rocks. Anderson Co., McGregor 1961, 2491; Cherokee Co., McGregor 1638; Crawford Co., McGregor 2523; Linn Co., McGregor 1948.

Thuidium virginianum (Brid.) Lindb.

On logs and bark of trees. Crawford Co., McGregor 1751; Jefferson Co., McGregor 1515; Miami Co., McGregor 1037.

Timmia megapolitana Hedw.

Sandy soil, open places in prairie. Mitchell Co., McGregor 1999; Riley Co., M. A. Carleton (KSC).

Tortella humilis (Hedw.) Jennings.

On limestone rocks, moist soil in woods. Bourbon Co., McGregor 1777; Cherokee Co., McGregor 1629, 1652; Linn Co., McGregor 1954.

Tortula pagorum (Milde) De Not.

Bark of elm trees. Cherokee Co., McGregor 1021; Douglas Co., McGregor 2655; Wilson Co., L. J. Gier, reported by Gier (1949), specimen in herbarium at William Jewell College, Liberty, Missouri.

Weisia viridula Hedw.

This is apparently one of the most common mosses in the state. I have found it in nearly every habitat I have visited. Barber Co., W. H. Horr 3115; Butler Co., McGregor 2245; Chase Co., McGregor 1811, 1815; Chautauqua Co., McGregor 1195; Cherokee Co., McGregor 1026, 1032, 1648; Clark Co., McGregor 2208; Clay Co., McGregor 2073; Cloud Co., McGregor 2067; Cowley Co., McGregor 2243, W. H. Horr 3167; Crawford Co., Holland 100 (KSC), Gier 730 (KSTCP); Douglas Co., McGregor 1164, Thompson March 14, 1948; Ford Co., McGregor 2211; Geary Co., F. C. Gates 18666 (KSC); Jewell Co., McGregor 2089; Johnson Co., McGregor 1334; Kingman Co., McGregor 2219, 2220; Kiowa Co., McGregor 2212; Leavenworth Co., McGregor 2260, 2262; Lincoln Co., McGregor 1988; Meade Co., McGregor 2203; Montgomery Co., McGregor 1175, 2396; Nemaha Co., McGregor 2020; Ottawa Co., F. C. Gates 19086 (KSC), McGregor 1317, 1319; Phillips Co., McGregor 2097; Pratt Co., McGregor 2218; Rawlins Co., McGregor 2135; Reno Co., McGregor 2222; Republic Co., McGregor 2086; Saline Co., McGregor 1488; Scott Co., McGregor 2163, 2174; Shawnee Co., McGregor 1230; Smith Co., McGregor 2093; Sumner Co., McGregor 2239; Washington Co., McGregor 2047; Wilson Co., McGregor 1277.

EXCLUDED LIST

The following is a list of mosses which have been reported for the state but which I am listing as excluded species. Unless otherwise indicated each is excluded because of a lack of specimen evidence. Others are excluded for reason given with the entry. If anyone knows of specimen evidence for any of the following species I would appreciate receiving such information. Many of them undoubtedly are present in Kansas.

Amblystegiella subtilis (Hedw.) Loeske.

Amblystegium cariosum (Sull.) This name does not occur in Grout's Moss Flora of North America. The authority for the name is also in doubt. I have found no one who has ever heard of this name.

Amblystegium compactum (C. M.) Aust.

Amblystegium radicale Bry. Eur. It is doubtful as to what this might have been. It was mentioned in an early paper by Smyth but he omitted it in his paper of 1911. Probably it was *A. varium*.

Archidium hallii Aust.

Astomum crispum Hampe. Grout (1928-1940) says this plant does not occur in North America. Entry might have been *Astomum muhlenbergianum* (Sw.) Grout.

Barbula convoluta Hedw.

Brachythecium acutum (Mitt.) Sull.

Brachythecium flagellare (Hedw.) Jennings.

Brachythecium rutabulum (L.) Bry. Eur.

Brothera leana (Sull.) C. M.

Campylium polygamum (Bry. Eur.) Bryhn.

Campylium stellatum (Schreb. Hedw.) Lang. and C. Jens.

Climacium dendoides (L.) Web. and Mohr.

Dicranella rufescens (Dicks. Sm.) Schimp.

Dicranum fucescens Turner.

Dicranum undulatum Turn. Is synonym of *Dicranium bonjeani* De Not. I have not found specimen evidence.

Didymodon recurvirostris (Hedw.) Jenn.

Ditrichum lineare (Sw.) Lindb.

Ditrichum pusillum (Hedw.) E. G. Britton.

Drepanocladus aduncus (Hedw.) Warnst.

Entodon sullivantii (C. M.) Lindb.

Ephemerum crassinervium (Schwaegr.) C. Mull. var. *papillosum* (Aust.) Ren. and Card.

Eurhynchium praelongum (Dill L.) Bryhn.

Eurhynchium rusciforme (Neck.) Milde.

Eurhynchium strigosum (Hoffn.) Bry. Eur.

Fabronia ciliaris (Brid.) Brid.

Fissidens bryoides Hedw.

Fissidens bryoides Hedw. var. *incurvus* (Starke) Monkem.

Fissidens exiguus Sull.

Fissidens osmundoides Hedw.

Fontinalis dalicarlica Bry. Eur.

Grimmia alpicola Hedw. var. *rivularis* (Brid.) Broth.

Grimmia apocarpa (L.) Hedw. var. *conferta* (Funck.) Spreng.

Grimmia apocarpa (L.) Hedw. var. *conferta* (Funck.) Spreng f. *obtusifolia* (Bry. Eur.) Moenk.

Grimmia calyptrata Hook.

Grimmia olneyi Sull.

Grimmia pilifera Beauv.

Grimmia wrightii Aust.

Gymnostomum aeruginosum Sm.

Hygroamblystegium fluviatile (Sw.) Loeske.

Hygroamblystegium noterophilum (Sull.) Warnst.

Hygrohypnum alspestre (Hedw.) Loeske.

Hypnum porphyrrhizum Lindb. and *Hypnum prophyrrizon* Lindb. Reported by Reed (1894) and Smyth (1941) are not in Grout (1928-1940). I am in

doubt as to what they might have had though it was probably *Amblystegium varium* (Hedw.) Lindl.

Hypnum vagans Drum.

Leptodictyum vacillans (Sull.) Broth.

Leskea polycarpa (Ehrh.) Hedw.

Mnium affine elatum Bry. Eur. Andrews in Moss Flora of North America discarded all varietal names of *Mnium affine.*

Mnium elatum Bry. Eur. Probably same as above.

Myrinia pulvinata (Wahlenb.) Schimp.

Orthotrichum anamalum Hedw.

Orthotrichum cupulatum (Hoffm.) Brid.

Orthotrichum cupulatum (Hoffm.) Brid. var *minus* Sulliv.

Orthotrichum speciosum Nees.

Phascum cuspidatum Hedw.

Philonotis longiseta (Rich) E. C. Britton.

Philonotis muhlenbergii (Schwaegr.) Brid.

Physcomitrium acuminatum (Schleich.) Bry. Eur.

Plagiothecium sylvaticum (Huds. Brid.) Bry. Eur.

Pleuridium bolanderi C. Muell.

Pohlia annotina (Hedw.) Loeske.

Polytrichum pilifercum Hedw.

Pylaisia intricata Bry. Eur.

Rhacomitrium aciculare Brid.

Sphagnum tabulare Sull.

Seligera pusilla (Hedw.) Bry. Eur.

Thuidium abietinum (L. Brid.) Bry. Eur.

Tortella caespitosa (Schwaegr.) Limpr.

Tortula mucronifolia Schwaegr.

Tricholepsis migrescens (Sw.) Grout

Trichostomum crispum Bruch.

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Type Localities of Mexican Reptiles and Amphibians

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ABSTRACT: This paper contains a list of the type localities of all the species of reptiles and amphibians at present recognized as belonging in the Mexican fauna. Type localities are also given for all species recognized as synonyms of those forms.

The following list includes the type localities of all forms of reptiles and amphibians at present recognized as occurring in Mexico whether the type localities are in Mexico or elsewhere. The localities are arranged in alphabetical order throughout; the genera and species are likewise arranged alphabetically within the eight groups (in the order listed) of caecilians, salamanders, anurans, turtles, amphisbaenians, lizards, snakes and crocodilians. The group to which each name belongs is indicated by the prefixes g, u, a, t, am, s, o and c, respectively. A number of forms mentioned in the current and pending check lists, on which this list is based (see Smith and Taylor, 1945, 1948, 1950) but not yet definitely known to occur in Mexico, have been included. All synonyms noted in the lists mentioned are likewise included. Recognized forms are cited by the name currently used printed in italicized bold-faced type; unrecognized synonyms are cited by their original name, unmodified, and printed in italics.

Compilation of the list has emphasized the surprising lack of and the need for restriction of type localities, many of which are currently expressed as "Mexico" or some other equally useless generality, or as a series of localities, none of which has been selected as the type locality. We have made an attempt to correct the lack

of preciseness in statement of type locality as much as possible, by restricting as many type localities as the present state of knowledge will permit. We have restricted type localities only to localities from which specimens are known to have been taken, and/or to those at which there is a reasonable possibility the type or types may have been secured.

We have omitted authors' names from scientific names in this list, inasmuch as a precise reference to the form to which we refer (together with author and location of original description) may be found under the name cited in the check lists mentioned. Inasmuch as the validity of our restrictions of type locality of numerous names hinges upon the clarity of bibliographic reference accompanying use of those names, we wish to reiterate that: **the bibliographic reference we intend to accompany each name cited herein whose type locality is designated "by present restriction" is to be found under that same name (unless otherwise indicated) in our check lists of 1945, 1948 and 1950 (see Smith and Taylor, those dates).** Some names * are not to be found in these check lists, having been proposed after the check lists were in press. They may be found in the articles cited in the bibliography.

EASTERN HEMISPHERE

CEYLON

No definite locality
t ***Caretta caretta gigas***

EGYPT

Cairo
s ***Hemidactylus turcicus turcicus*** (by present restriction)

INDIA

Malabar
t *Chelonia dussumieri*
Vizagapatam
o ***Typhlops braminus***

JAVA

No definite locality
s ***Hemidactylus frenatus***

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* *Thorius minutissimus, Thorius macdougalli, Ptychohyla bogerti, Plectrohyla brachycephala, Hyla proboscidea, Hyla dalquesti, Rana moorei, R. pipiens austricola, Arizona elegans eburnata, A. e. expolita, A. e. pacata, A. e. philipi, Crotalus basiliscus oaxacus, C. gloydi lautus, Ficimia publia taylori, Hypsiglena ochrorhyncha klauberi, H. o. texana, H. o. tortugaensis, H. unaocularis, Micrurus nigrocinctus wagneri, Phyllorhynchus browni fortitus, Pituophis catenifer bimaris, P. c. coronalis, P. c. fuliginosus, P. c. insulanus, P. deppei brevilineata, Pseudoficimia hiltoni, Rhadinaea marcellae, Salvadora hexalepis klauberi, Schmidtophis rubriventris, Tantilla shawi, Thamnophis melanogaster lineris, T. sumichrasti salvini,* and *Toluca amphisticha.*

PHILIPPINE ISLANDS

Manila
- t ***Lepidochelys olivacea***
- s ***Peropus mutilatus***

PINE ISLAND

No definite locality
- o ***Pelamis platurus***

RED SEA

No definite locality
- t *Caretta bissa*

SICILY

Palermo
- t ***Dermochelys coriacea*** (by present restriction)

STRAITS SETTLEMENTS

Singapore
- t ***Eretmochelys squamata*** (by restriction)

WESTERN HEMISPHERE

No definite locality
- s ***Anolis damulus***
- s ***Anolis impetigosus***
- s *Phyllodactylus mentalis*
- s *Phyllodactylus pulcher*
- o ***Dipsas bertholdi***
- o ***Erythrolamprus aesculapii***
- o ***Tropidodipsas annulifera***
- o ***Typhlops longissimus***

ATLANTIC OCEAN

ASCENSION ISLAND

No definite locality
- t *Chelonia maculosa* (by present restriction)
- t ***Chelonia mydas***

BERMUDA ISLANDS

No definite locality
- t ***Caretta caretta caretta*** (by present restriction)
- t *Chelonia lachrymata* (by present restriction)
- t *Chelonia pseudo-caretta* (by present restriction)
- t *Chelonia pseudo-mydas* (by present restriction)
- t *Chelonia virgata* (by present restriction)
- t ***Eretmochelys imbricata*** (by present restriction)

CENTRAL AMERICA

BRITISH HONDURAS

Belize
- t *Dermatemys abnormis* (by present restriction)
- s ***Anolis ustus***
- s ***Coleonyx elegans elegans***
- o ***Elaphe triaspis*** (by present restriction)
- o *Herpetodryas incertus*
- o ***Leptodeira annulata polysticta*** (by restriction)
- o ***Micrurus affinis alienus*** (by present restriction)
- o *Micrurus affinis stantoni*
- o ***Thamnophis sumichrasti praeocularis*** (by present restriction)
- o ***Tretanorhinus nigroluteus lateralis*** (by present restriction)
- c *Alligator lacordairei*

Cohune Ridge (20 miles southeast of Benque Viejo)
- s ***Sceloporus lundelli lundelli***

Double Falls (west of Stann Creek)
- o *Pliocercus elapoides semicinctus*

St. George Island (near Belize)
- s ***Aristelliger georgeensis***

COSTA RICA

No definite locality
- s *Mabuia alliacea*

Arriba
- a ***Bufo coccifer***
- s *Anolis nannodes* (by present restriction)

Bebedero
- a ***Hyla underwoodi***

Palmar
- s ***Anolis capito*** (by present restriction)
- s ***Leiolopisma cherriei cherriei***

Palomo (Valle de Orosi)
- a ***Anotheca coronata***

San José
- a ***Centrolenella fleischmanni***

San Mateo
- s *Cnemidophorus alfaronis*

EL SALVADOR

Izalco, Volcán
- s ***Leiolopisma assatum assatum***
- o ***Imantodes gemmistratus***

La Unión
- t ***Geoemyda pulcherrima incisa***
- s *Ctenosaura completa* (by present restriction)
- s *Sceloporus fulvus*
- o ***Loxocemus bicolor***
- o *Plastoseryx bronni* (by present restriction)
- o ***Stenorrhina freminvillii lactea*** (by present restriction)

GUATEMALA

No definite locality
- o ***Agkistrodon bilineatus*** (Pacific coast of Guatemala)
- o ***Amastridium sapperi***
- o ***Pliocercus elapoides diastemus*** (plateau of)
- o ***Tantilla jani***

ALTA VERAPAZ

No definite locality
- t *Claudius pictus* (by present restriction)
- o *Petalognathus multifasciatus* (by present restriction)

Cobán
- a ***Agalychnis moreletii***
- a *Hyla holochlora*
- t *Cinosternum cobanum* (by present restriction)
- s *Anolis petersii bivittatus* (by present restriction)
- s ***Anolis stuarti***
- s ***Sceloporus malachiticus taeniocnemis*** (by present restriction)
- o *Bothriechis nummifera notata*
- o *Bothrops mexicanus*
- o ***Bothrops nigroviridis aurifer***
- o ***Drymobius chloroticus***
- o ***Micrurus affinis apiatus*** (by present restriction)
- o ***Thamnophis sumichrasti fulvus*** (by present restriction)

Cubilguitz
- o *Leptognathus cuculliceps* (by present restriction)
- o *Leptognathus semicinctus* (by present restriction)
- o ***Thamnophis sumichrasti salvini***

Panzós, Río Polochic
- t ***Chelydra rossignonii***
- s ***Ameiva festiva edwardsii*** (Santa María de, by present restriction)
- s *Anolis copei*
- s ***Anolis limifrons rodriguezii***
- o ***Bothrops nasutus***

Samac, Finca (6 kilometers west of Cobán)
- s ***Anolis petersii*** (by present restriction)

Volcán, Finca (49 kilometers east of Cobán)
- s ***Xenosaurus rackhami***

BAJA VERAPAZ

No definite locality
- s *Anolis carneus*

San Gerónimo
- o ***Pliocercus aequalis***

EL PETÉN

Flores
- o ***Coniophanes quinquevittatus*** (by present restriction)
- o ***Tantilla moesta*** (by present restriction)

Ixpuc Aguada (north of La Libertad)
- a ***Hyla loquax***

La Libertad
- t ***Geoemyda areolata*** (by present restriction)
- t *Gymnodactylus coleonyx* (by present restriction)
- s *Gymnodactylus scapularis* (by present restriction)
- o ***Thalerophis occidentalis praestans*** (by present restriction) *

Petén, Laguna de
- c ***Crocodylus moreletii***

Piedras Negras
- a ***Eleutherodactylus conspicuus***
- o ***Dendrophidion vinitor***
- o ***Scaphiodontophis carpicinctus***
- o ***Tantillita lintoni***
- o ***Xenodon mexicanus***

Río de la Pasión
- s ***Lepidophyma flavomaculatum flavomaculatum*** (by present restriction)

Santa Teresa, 2 miles north of
- s ***Anolis humilis uniformis*** (by present restriction)
- s *Anolis ruthveni*

ESCUINTLA

Escuintla
- s ***Corythophanes percarinatus***
- o ***Thamnophis sumichrasti cerebrosus***

GUATEMALA

Guatemala
- o ***Geophis nasalis***

HUEHUETENANGO

Canibal, Finca (3,000 ft.)
- s ***Sceloporus melanorhinus stuarti***

RETALULEU

Huamuchil
- t *Staurotypus biporcatus*
- t ***Staurotypus salvinii***

Retaluleu
- o *Peropodum guatemalensis*
- o ***Ungaliophis continentalis***

SACATEPEQUEZ

Antigua, Volcán
- s ***Sceloporus squamosus*** (by present restriction)

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* Formerly *Leptophis occidentalis praestans.*

SOLOLÁ

Atitlán
- s ***Celestus atitlanensis***
- o ***Drymobius margaritiferus occidentalis*** (Volcán)
- o *Leptognathus sexscutatus*
- o ***Tropidodipsas fischeri*** (Volcán) (by present restriction)
- o *Virginia fasciata* (by present restriction)

San Agustín, 610 m. (near Volcán de Atitlán)
- s ***Sceloporus malachiticus acanthinus***
- o *Bothrops affinis*
- o ***Bothrops bicolor***

SUCHITEPEQUEZ

Finca El Ciprés, Volcán Zunil
- o ***Adelphicos quadrivirgatus sargii*** (by present restriction)
- o ***Micrurus latifasciatus***
- o ***Micrurus nigrocinctus zunilensis***

Mazatenango
- s *Akleistops guatemalensis*
- s ***Ameiva undulata parva*** (by restriction)
- s ***Lepidophyma smithii smithii*** (by restriction)
- o *Leptognathus bernoullii* (Hacienda de Chitalón)
- o ***Tropidodipsas sartorii annulatus*** (Hacienda de Chitalón, by present restriction)

Río Nagualate
- t *Chelonia agassizii*
- t *Emys grayi*
- t ***Pseudemys umbra***
- c *Crocodilus pacificus*

TOTONICAPAM

Totonicapam
- o ***Bothrops godmani***

YZABAL

Yzabal
- o *Spilotes salvini* (by present restriction)

ZACAPA

Río Motagua, Valley of (10 kilometers northeast of Zacapa)
- s *Cnemidophorus motaguae*

HONDURAS

No definite locality
- t *Emys venusta*
- t *Cristasaura mitrella*
- o ***Coniophanes fissidens punctigularis***
- o *Microphis quinqueliniatus*
- o ***Pseustes poecilonotus poecilonotus***

Lancetilla
- s *Eumeces schmidti*

Portillo Grande (Yoro)
o ***Adelphicos quadrivirgatus visoninus*** (by present restriction)
Tela
s ***Ctenosaura similis similis*** (by restriction)

NICARAGUA

No definite locality
a ***Hyla ebraccata***
s *Cnemidophorus decemlineatus*
Greytown
s *Basiliscus nuchalis*
s *Draconura bivittata* (by present restriction)
Laguna Island
o ***Hypsiglena torquata***
Rama
s ***Gonatodes fuscus*** (by present restriction)
Recero
a ***Leptodactylus melanonotus*** (by present restriction)

PANAMÁ

No definite locality
s *Anolis panamensis*
Chiriquí, Río (in vicinity of Bocas del Toro)
a ***Bufo simus***
Obispo
o ***Bothrops atrox asper***
Veragua
s ***Sphaerodactylus lineolatus***

NORTH AMERICA

MEXICO

State unknown
u ***Magnadigita sulcata***
u *Spelerpes punctatum*
a ***Eleutherodactylus longipes***
a ***Hyla crassa***
a ***Hyla plicata***
t *Cinosternum brevigulare* (Playa Vicente)
s ***Anolis baccatus***
s ***Anolis cumingii***
s *Anolis guntherii*
s ***Anolis heliactin***
s ***Anolis metallicus***
s ***Anolis schiedii***
s ***Urosaurus irregularis*** (highlands)
o ***Anomalepis mexicana***
o ***Dipsas brevis***
o ***Dipsas dimidiatus***
o *Erythrolamprus guentheri*
o ***Geophis chalybeus***

o ***Geophis rostralis***
o ***Geophis sieboldi*** (?)
o ***Helicops septemvittata***
o ***Rhadinaea taeniata***
o ***Sonora aequalis***
o ***Tantilla deppei***
o ***Tantilla mexicana***
o ***Typhlops psittacus***

BAJA CALIFORNIA
No specific locality
s ***Phyllodactylus tuberculosus*** (Californien)
Mainland localities
Agua Caliente (Cape region)
o ***Crotalus lucasensis***
Agua Verde Bay
s *Callisaurus plasticus*
Alcatraz
o ***Lampropeltis zonata agalma***
Ballenas Bay
s ***Callisaurus draconoides crinitus***
Comondú
s ***Eumeces lagunensis*** (on trail between Loreto and; neotype locality)
s ***Petrosaurus repens***
o ***Sonora mosaueri***
Ensenada
s *Cnemidophorus stejnegeri*
o *Lichanura myriolepis* (by present restriction)
o ***Lichanura roseofusca roseofusca*** (by present restriction)
Estero Salina
o ***Chilomeniscus stramineus esterensis***
Gardners Laguna, Salton River
s ***Callisaurus draconoides gabbii*** (by present restriction)
La Paz
s ***Coleonyx variegatus peninsularis***
s *Crotaphytus copeii*
s ***Uta stansburiana elegans***
o *Chilomeniscus stramineus fasciatus*
o ***Leptotyphlops humilis slevini***
Las Palmas
s *Crotaphytus fasciolatus*
Los Dolores
t ***Pseudemys scripta nebulosa***
Puerto Escondido
o ***Hypsiglena slevini***
San Bartolomé Bay
s *Cnemidophorus bartolomas*
s ***Phrynosoma coronatum jamesi***
s *Uta parva*

San Fernando Misión (between San Ignacio and)
- o ***Phyllorhynchus decurtatus decurtatus*** (by present restriction)

San Francisquito (Sierra de la Laguna)
- s ***Eumeces lagunensis***
- s ***Xantusia gilberti***

San Francisquito Bay
- s ***Sauromalus australis***

San Ignacio
- o ***Thamnophis digueti*** (by restriction)

San Jorge, 2 miles east of
- o ***Sonora baucroftae***

San José del Cabo
- s ***Dipsosaurus dorsalis lucasensis***
- o *Lampropeltis nitida* (= ***L. getulus nitida***)

San Lucas, Cape
- a *Hyla curta*
- a *Hyla regilla laticeps*
- a *Scaphiopus varians*
- am ***Bipes biporus***
- s ***Callisaurus draconoides draconoides*** (by present restriction)
- s ***Cnemidophorus hyperythrus hyperythrus***
- s ***Cnemidophorus maximus***
- s ***Ctenosaura hemilopha***
- s *Ctenosaura interrupta* (by present restriction)
- s ***Petrosaurus thalassinus***
- s ***Phrynosoma coronatum coronatum*** (by present restriction)
- s ***Phyllodactylus unctus***
- s *Phyllodactylus xanti*
- s ***Sceloporus magister zosteromus***
- s ***Urosaurus nigricaudus***
- o ***Chilomeniscus stramineus stramineus***
- o ***Crotalus enyo***
- o ***Crotalus mitchellii mitchellii***
- o ***Hypsiglena ochrorhyncha ochrorhyncha***
- o ***Lampropeltis getulus conjuncta***
- o ***Lichanura trivirgata***
- o ***Masticophis aurigulus***
- o ***Natrix valida celaeno***
- o ***Pituophis catenifer vertebralis*** (by present restriction)
- o *Pityophis haematois*
- o ***Salvadora hexalepis klauberi***
- o ***Tantilla planiceps*** (by present restriction)
- o ***Trimorphodon lyrophanes***
- o *Tropidonotus tephropleura*

San Pedro Mártir Mountains
- s ***Urosaurus microscutatus***
- o *Crotalus goldmani* (El Piñon, 5,300 ft.)

o *Thamnophis ordinoides hueyi* (= ***T. elegans hueyi***)
(Arroyo Encantado)
San Quintín
s *Phrynosoma nelsoni*
San Quintín Bay
s ***Sceloporus magister rufidorsum***
Santa Gertrudis, near El Arco
o ***Pituophis catenifer bimaris***
Santa Rosalía
s *Sceloporus digueti*
o ***Elaphe rosaliae***
o ***Hypsiglena ochrorhyncha venusta*** (by present restriction)
Santo Domingo
s *Callisaurus rhodostictus* (by present restriction)
o ***Arizona elegans pacata***
Sierra San Lázaro
s ***Sceloporus orcutti licki***
Tecate
s *Phrynosoma ochoterenai*
Todos Santos
s ***Elgaria paucicarinata***
Insular localities
Ángel de la Guarda
s ***Callisaurus draconoides splendidus***
s ***Crotaphytus insularis***
s ***Sauromalus hispidus***
o *Crotalus atrox elegans*
Carmen
s ***Callisaurus draconoides carmenensis***
s ***Cnemidophorus hyperythrus caeruleus***
s *Cnemidophorus vandenburghi*
s ***Dipsosaurus carmenensis***
s ***Uta mannophorus***
Cedros
s ***Cnemidophorus hyperythrus beldingi***
s ***Cnemidophorus tigris multiscutatus***
s ***Cnemidophorus labialis***
s ***Elgaria cedrosensis***
s ***Phrynosoma cerroense***
s *Phrynosoma schmidti*
s ***Uta concinna***
o ***Crotalus exsul***
o ***Pituophis catenifer insulanus***
Ceralvo
s ***Cnemidophorus ceralbensis***
s *Ctenosaura insulana*
s ***Sator grandaevus***
Los Coronados
u ***Batrachoseps attenuatus leucopus*** (North Island)
s ***Elgaria multicarinata nana*** (South Island)

- o ***Hypsiglena ochrorhyncha klauberi*** (South Island)
- o ***Pituophis catenifer coronalis*** (South Island)

Espíritu Santo
- s ***Sauromalus ater*** (by present restriction)
- s *Verticaria espiritensis*

Isla Partida
- s *Cnemidophorus dickersonae* (near Ángel de la Guarda)
- o *Chilomeniscus punctatissimus* (near Espíritu Santo)
- o ***Masticophis barbouri*** (near Espíritu Santo)

Mejía
- s ***Streptosaurus slevini***

Monserrate
- s ***Cnemidophorus hyperythrus pictus***
- s ***Sauromalus slevini*** (southern end)
- s ***Sceloporus magister monserratensis***

Sal Si Puedes
- s ***Cnemidophorus tigris canus***

San Benito
- s ***Uta stellata***

San Francisco
- s *Verticaria franciscensis*

San Gerónimo
- s ***Anniella geronimensis***

San José
- s ***Cnemidophorus hyperythrus danheimae***
- s ***Cnemidophorus tigris celeripes***

San Marcos
- s ***Cnemidophorus hyperythrus schmidti***

San Martín
- s *Gerrhonotus scincicauda ignavus*
- s ***Uta martinensis***
- o ***Pituophis catenifer fuliginatus***

Santa Catalina
- s ***Cnemidophorus catalinensis***
- s ***Dipsosaurus catalinensis***
- s ***Sauromalus klauberi***
- s ***Sceloporus magister lineatulus***
- s ***Uta squamata***
- o ***Lampropeltis catalinensis***

Santa Cruz
- s ***Sator angustus***

Santa Inez, South
- s ***Coleonyx variegatus slevini***

Santa Margarita
- s ***Cnemidophorus tigris rubidus***
- o *Zamenis lateralis fuliginosus*

Todos Santos, South
- o ***Diadophis amabilis anthonyi***
- o ***Lampropeltis zonata herrerae***

Tortuga
- o ***Crotalus tortugensis***
- o ***Hypsiglena ochrorhyncha tortugaensis***

CAMPECHE

No definite locality
- s ***Eumeces schwartzei*** (a small island in the Laguna de Términos)

Balchacaj
- s *Ctenosaura (Cachryx) annectens* (by present restriction)
- s ***Enyaliosaurus erythromelas*** (by present restriction)
- o ***Imantodes splendidus luciodorsus***

Encarnación
- a ***Hypopachus cuneus nigroreticulatus***

Panlao
- s ***Anolis sagrei mayensis***

Tuxpeña
- o ***Leptodeira yucatanensis malleisi***

CHIAPAS

Chícharros
- u ***Bolitoglossa flaviventris***
- o ***Geophis cancellatus***

Ciudad de las Casas, 11 kilometers southeast of, 2,300 m.
- s ***Barisia moreleti temporalis***

Conjab, between San Bartolomé and Comitán, 5,300 ft.
- s ***Sceloporus prezygus***

Finca Germania, 4 miles northeast of Huixtla, 3,300 ft.
- o *Micrurus nigrocinctus wagneri*

La Esperanza, near Escuintla
- u ***Bolitoglossa occidentalis***
- a ***Acrodytes modesta*** (Cruz de Piedra)
- a ***Bufo angustipes***
- a ***Microbatrachylus imitator***
- a ***Syrrhophus rubrimaculatus***
- s *Sceloporus guentheri* (by present restriction)
- o ***Drymarchon corais unicolor***
- o ***Scaphiodontophis albonuchalis***

La Libertad
- s ***Ameiva undulata thomasi***

Malé, Cerro, 3,200 m.
- s ***Gerrhonotus liocephalus austrinus***

Mineral de Santa Fé
- s *Eumeces rovirosae*

Ovando, Cerro
- u ***Chiropterotriton xolocalcae***
- u ***Magnadigita nigroflavescens***
- a ***Eleutherodactylus matudai***
- a ***Hyla rozellae*** (Salto de Agua)
- a ***Microbatrachylus montanus***

a ***Plectrohyla matudai***
a ***Plectrohyla sagorum***
o ***Elaphe flavirufa matudai*** (Salto de Agua)
o *Micrurus nigrocinctus ovandoensis* (Salto de Agua)
o ***Rhadinaea lachrymans*** (by present restriction)

Palenque
u ***Bolitoglossa moreleti***
s ***Ameiva undulata stuarti***
s ***Celestus rozellae***
o ***Coniophanes bipunctatus biseriatus***
o *Thamnophis rozellae*

Piedra Parada
s ***Anolis biporcatus*** (by present restriction)

Piedras Negras, Guatemala, across Río Usumacinta from
s ***Ameiva undulata hartwegi***

San Cristobal
o ***Adelphicos veraepacis nigrilatus***

San Ricardo
a ***Hypopachus maculatus***

Santa Rosa, near Comitán
s ***Abronia ochoterenai***

Siltepec, 16 miles south of, 2,300 m.
s ***Barisia moreleti rafaeli***

Tacaná, Volcán de
s ***Abronia matudai***

Tapachula
a ***Hyla beltrani***
a ***Hyla robertmertensi***

Tonalá
a ***Syrrhophus nebulosus***
o *Conophis pulcher plagosus*
o ***Conophis pulcher similis*** (by present restriction)
o ***Tantillita brevissima***
c *Alligator Chiapasius*

Tuxtla Gutiérrez
t ***Kinosternon abaxillare***
s ***Sceloporus carinatus***

CHIHUAHUA

No definite locality
s ***Barisia levicollis*** * (by present restriction)
o ***Trimorphodon vilkinsonii***

Batopilas
s ***Urosaurus unicus*** (?)
o ***Procinura aemula***

Batosegachic
o ***Micrurus diastema distans***

* Originally stated "Mexican Boundary," the type locality cannot reasonably be restricted further than "Chihuahua" at the present time, inasmuch as no specimens are yet known from localities near the U. S. boundary in that state.

Casas Grandes
- o ***Arizona elegans expolita***

Chihuahua
- a ***Bufo insidior***
- s *Cnemidophorus gularis gularis obsoletus*
- s *Cnemidophorus gularis gularis verus*
- s *Cnemidophorus sackii scalaris*
- s *Cnemidophorus sexlineatus tigris* Cope (nec Baird and Girard)
- s ***Urosaurus ornatus caeruleus*** (30 miles north of)

Colonia García
- o *Thamnophis ordinoides errans* (= ***Thamnophis errans***)

Guasaremos, Río Mayo
- o ***Tantilla yaquia***

Juárez, 15 miles south of
- s ***Holbrookia bunkeri***

Mojárachic
- u ***Ambystoma fluvinatum***
- u ***Ambystoma rosaceum***
- a ***Eleutherodactylus tarahumaraensis***
- s ***Elgaria kingii kingii*** (by present restriction)
- s *Gerrhonotus multifasciatus* (by present restriction)
- o ***Crotalus semicornutus***
- o ***Lampropeltis knoblochi***

Presidio del Norte
- o *Churchillia bellona*

San Buenaventura, 11 miles south of
- o ***Masticophis flagellum lineatulus***

Sierra Madre, lat. 26°6′ N., long. 106°50′ W.
- u *Axolotes maculata*

Yoquivo
- a ***Rana tarahumarae*** (by present restriction)

COAHUILA

Agua Nueva
- s *Cnemidophorus semifasciatus*

Arteaga
- s ***Sceloporus jarrovii oberon***

Buena Vista
- o ***Pituophis deppei jani***

Castañuelas
- s ***Holbrookia maculata dickersonae***

Cuatro Ciénegas
- t ***Terrapene coahuila***

El Salado, San Luis Potosí, 30 miles north of
- s ***Sceloporus cautus***

Monclova
- o *Crotalus (tigris) palmeri*
- o ***Rhinocheilus lecontei tessellatus***

Nazas, Río
- a *Scaphiopus rectifrenis*

Parras
- s *Cnemidophorus variolosus*
- o ***Thamnophis angustirostris***

Patos
- s ***Sceloporus ornatus ornatus***

Rinconada
- o ***Thamnophis eques cyrtopsis***

San Pedro (de las Colonias)
- s ***Sceloporus ornatus caeruleus*** (5 miles south of)
- s ***Uma exsul*** (sand dunes 12 miles north of)

Sierra Guadalupe
- s ***Barisia imbricata ciliaris***

COLIMA

No specific locality
- s ***Phrynosoma orbiculare dugesii***
- s ***Sceloporus dugesii dugesii***
- o ***Geophis semiannulatus***
- o ***Leptotyphlops dugesii***

Colima
- a ***Agalychnis dacnicolor***
- a *Bufo argillaceous* (by present restriction)
- s ***Cnemidophorus communis copei*** (by present restriction)
- s ***Cnemidophorus deppii lineatissimus*** (by present restriction)
- s ***Cnemidophorus sackii communis*** (by present restriction)
- s *Ctenosaura brevirostris*
- s ***Ctenosaura pectinata*** (by restriction)
- s ***Eumeces colimensis***
- s ***Phrynosoma asio*** (by present restriction)
- s ***Sceloporus horridus oligoporus***
- s ***Sceloporus pyrocephalus***
- s ***Sceloporus utiformis***
- s ***Urosaurus bicarinatus tuberculatus***
- o ***Crotalus basiliscus basiliscus*** (by present restriction)
- o *Elaps epistema* (by present restriction)
- o *Elaps fulvius hypostema* (by present restriction)
- o ***Micrurus diastema diastema*** (by present restriction)
- o ***Pseudoficimia frontalis*** (by present restriction)
- o *Pseudoficimia pulchra* (by present restriction)

Comala
- o ***Tropidodipsas occidentalis***

Manzanillo
- s ***Ameiva undulata sinistra***
- s ***Anolis schmidti***

Paso del Río, Hacienda
- a ***Syrrhoplus modestus***
- s ***Coleonyx elegans nemoralis***
- o ***Dipsas gaigeae***
- o ***Leptotyphlops phenops bakewelli***

Santiago
- s ***Leiolopisma assatum taylori***

Revillagigedos Archipelago
- s ***Urosaurus auriculatus*** (Socorro Island)
- s ***Urosaurus clarionensis*** (Clarión Island)
- o ***Hypsiglena unaocularis*** (Clarión Island)
- o ***Masticophis anthonyi*** (Clarión Island)

DISTRITO FEDERAL

Coyoacán
- a ***Hyla eximia*** (by present restriction)
- a *Scaphiopus dugesii* (by present restriction)
- a ***Scaphiopus multiplicatus*** (by present restriction)
- o ***Crotalus triseriatus anahuacus*** (by present restriction)
- o *Oxyrhina de filippii* (by present restriction)
- o ***Toluca lineata lineata*** (by present restriction)

Desierto de los Leones
- a ***Hyla lafrentzi***

Laguna Santa Isabel, near Guadalupe Hidalgo
- u ***Ambystoma velasci***
- u *Siredon tigrina*

Magdalena
- s *Scincus ventralis* (by present restriction)

México (City)
- a *Rana adtrita* (by present restriction)
- a ***Rana montezumae***
- s *Agama torquata* Peale and Greene (by present restriction)
- s ***Barisia imbricata imbricata*** (by present restriction)
- s *Gerrhonotus lichenigerus* (by present restriction)
- s ***Phrynosoma orbiculare orbiculare*** (by present restriction)
- s *Phrynosoma wiegmanni* (by present restriction)
- s ***Sceloporus grammicus microlepidotus*** (by present restriction)
- s ***Sceloporus scalaris scalaris*** (by present restriction)
- s ***Sceloporus torquatus torquatus*** (by present restriction)
- s *Tapaya orbicularis longicaudatus* (by present restriction)
- o ***Diadophis dugesii*** (Potreros de Balbuena, near)
- o *Eutaenia flavilabris* (by present restriction)
- o *Eutaenia insigniarum* (Chapultepec)
- o *Eutaenia macrostemma*
- o ***Geophis bicolor*** (?)
- o ***Rhadinaea laureata***
- o ***Thamnophis scalaris scaliger*** (by present restriction)

San Diego
- s *Gerrhonotus olivaceus* (by present restriction)

Serranía de las Cruces, Manantial de los Axolotes
- u ***Rhyacosiredon altamirani***

Xochimilco
- u ***Siredon mexicanum*** (by present restriction)
- a *Bufo anomalus* (by present restriction)

a ***Bufo compactilis compactilis*** (by present restriction)
a *Bufo levifrons* (by present restriction)
a *Bufo mexicanus* (by present restriction)
o ***Thamnophis melanogaster melanogaster*** (by present restriction)
o *Tropidonotus mesomelanus* (by present restriction)

DURANGO

No specific locality
s ***Phrynosoma douglassii brachycercum***
o ***Natrix valida valida***

Pedriceña
s ***Sceloporus lineolateralis*** (6 miles northeast of)
s ***Sceloporus maculosus*** (14 miles northeast of)

Ventanas
a ***Rana pustulosa***
s ***Coleonyx fasciatus***

GUANAJUATO

Acámbaro
o *Lampropeltis triangulum nelsoni* **(*L. doliata nelsoni*)**
o ***Salvadora bairdii*** (by present restriction)

Guanajuato
a ***Bufo monksiae*** (by present restriction)
a *Bufo occidentalis* (by present restriction)
a ***Eleutherodactylus augusti***
a *Rana montezumae concolor* (by present restriction)
a ***Syrrhophus guttilatus***
t *Cinosternum rostellum*
s ***Eumeces callicephalus*** (by present restriction)
s ***Eumeces dugesii*** (by present restriction)
s *Sceloporus ferrariperezi* (by present restriction)
o ***Conopsis nasus*** (by present restriction)
o *Epirhina tessellata* (by present restriction)
o *Eutaenia pulchrilatus*
o *Hemigenius variabilis*
o ***Hypsiglena ochrorhyncha janii*** (by present restriction)
o ***Masticophis taeniatus australis*** (by present restriction)
o ***Micrurus fitzingeri fitzingeri*** (by present restriction)
o *Oxyrhina (Exorhina) maculata* (by present restriction)
o ***Tantilla bocourti*** (by present restriction)
o *Thamnophis cyrtopsis cyclides* (by present restriction)

Salamanca
o *Thamnophis stejnegeri*

Sierra de Santa Rosa
o *Oreophis boulengeri*

Tupátaro
s ***Sceloporus torquatus melanogaster*** (by present restriction)
o *Crotalus lugubris multimaculata* (by present restriction)
o ***Crotalus polystictus*** (by present restriction)

GUERRERO

Acapulco
- t ***Kinosternon integrum*** (by present restriction)
- s ***Anolis taylori*** (1 mile north of)
- s ***Phyllodactylus magnatuberculatus***
- s ***Sceloporus melanorhinus calligaster***
- o ***Conophis vittatus vittatus*** (Laguna Coyuca, by present restriction)
- o ***Dryadophis melanolomus stuarti***
- o ***Imantodes gracillimus*** (by present restriction)
- o ***Micrurus nuchalis taylori***
- o ***Salvadora lemniscata*** (by present restriction)
- o ***Trimorphodon biscutatus semirutus***

Agua del Obispo (between Rincón and Cajones)
- a ***Centrolenella viridissima***
- a ***Hyla erythromma***
- a ***Hyla pinorum***
- a ***Hypopachus caprimimus***
- a ***Microbatrachylus minimus***
- a ***Ptychohyla adipoventris***
- a ***Rana sierramadrensis***
- a ***Tomodactylus albolabris***
- s ***Anolis dunni***
- s ***Anolis megapholidotus***

Amula
- a ***Tomodactylus amulae***

Balsas, Río
- o *Leptodeira guilleni*

Buena Vista
- o ***Tropidodipsas guerreroensis***

Chilpancingo
- a ***Hyla melanomma*** (7 miles east of)
- s ***Sceloporus grammicus grammicus*** (by present restriction)
- s *Sceloporus pleurostictus* Weigmann (by present restriction)
- o ***Enulius unicolor*** (by present restriction)
- o ***Leptotyphlops maximus***
- o *Micrurus browni* (= ***M. nigrocinctus browni***)
- o ***Salvadora intermedia intermedia***
- o ***Tantilla coronadoi***

El Treinte
- o ***Rhadinaea hesperia baileyi***
- o ***Tantilla martindelcampoi***

Huajintlán (at Morelos border)
- s *Heloderma Hernandesii* (by present restriction)
- s ***Heloderma horridum*** (by present restriction)
- o ***Pseudoficimia pulcherrima*** (by present restriction)
- o ***Pseudoleptodeira latifasciata*** (by present restriction)

La Venta
- a ***Acrodytes inflata***
- a ***Bufo gemmifer*** (El Limoncito, near)
- o ***Coniophanes fissidens dispersus*** (El Limoncito, near)

Malinaltepec
- a ***Hyla leonard-schultzei***

Mazatlán
- a ***Syrrhophus pipilans*** (9 miles south of)
- s ***Eumeces ochoterenai***
- s ***Sceloporus ochoterenae*** (2 miles north of)

Mexcala
- a ***Bufo perplexus***
- am ***Bipes canaliculatus*** (by present restriction)
- am *Chalcides sulcata* (by present restriction)
- am *Chamaesaura propus* (by present restriction)
- am *Lacerta lumbricoides* (by present restriction)
- am *Lacerta mexicana* (by present restriction)

Mezquititlán (north of Chilpancingo)
- s ***Sceloporus gadovii***

Omilteme
- a ***Eleutherodactylus calcitrans*** (by restriction)
- a ***Eleutherodactylus saltator***
- a ***Hyla arboricola*** (6 miles east of)
- a *Rana omiltemana*
- s ***Abronia deppii*** (by present restriction)
- s ***Anolis liogaster*** (7,600 ft.)
- s ***Barisia gadovii gadovii***
- s ***Sceloporus formosus scitulus***
- s ***Sceloporus mucronatus omiltemanus*** (8,000 ft.)
- s *Sceloporus rubriventris*
- o *Agkistrodon browni*
- o ***Bothrops barbouri***
- o ***Crotalus omiltemanus***
- o ***Geophis omiltemana***
- o ***Rhadinaea aemula*** (by present restriction)
- o ***Rhadinaea hesperia hesperia*** (by present restriction)
- o ***Rhadinaea omiltemana***
- o ***Thamnophis scalaris godmani***

Rincón
- s ***Ameiva undulata dextra***

Taxco
- s ***Phyllodactylus bordai*** (6 miles north of)
- o *Sonora erythrura* (10 miles south of)

Tecpán de Galeana
- am ***Bipes tridactylus***
- o ***Geatractus tecpanecus***

Tierra Colorada
- s ***Anolis gadovii***
- s ***Phyllodactylus delcampi***
- s ***Phyllodactylus lanei***
- s ***Phyllodactylus magnus***
- s ***Sceloporus stejnegeri***

Tixtla
- o ***Ficimia ruspator*** (3 miles east of)

Hidalgo

Durango
- u ***Chiropterotriton chondrostega***
- u ***Chiropterotriton mosaueri*** (7,200 ft.)
- s ***Gaigeia gaigeae***
- o ***Ninia diademata plorator***
- o ***Rhadinaea crassa***

El Chico
- a ***Hyla robertsorum*** (Parque Nacional)
- s ***Abronia taeniata taeniata***
- s ***Eumeces lynxe lynxe***
- s *Plestiodon bellii*

El Pinalito
- s ***Sceloporus jarrovii immucronatus*** (10 miles north of)

Guerrero (near Mineral del Monte)
- u ***Chiropterotriton dimidiata***
- u ***Pseudoeurycea cephalica manni***

LaPlacita (south of Jacala), 7,000 ft.
- a ***Tomodactylus macrotympanum***
- s ***Leiolopisma forbesorum***

Santa Anita
- u ***Pseudoeurycea cephalica rubrimembris*** (6 kilometers south of)

Tianguistengo
- u ***Chiropterotriton arborea***
- u ***Chiropterotriton terrestris*** (6 miles south of, 5,000 ft.)
- a ***Eleutherodactylus hidalgoensis*** (4 miles west of)
- a ***Hyla bromeliana***

Zacualtipan
- a ***Syrrhophus verrucipes*** (1,800 ft. lower than)
- s ***Gaigeia sylvatica*** (7 miles north of)
- o ***Geophis mutitorques***
- o ***Micrurus bernadi***
- o ***Storeria hidalgoensis***
- o ***Thamnophis phenax halophilus*** (7 miles north of)

Zimapán
- s ***Phrynosoma boucardi*** (by present restriction)

Jalisco

Barranca Íbarra
- s *Ctenosaura parkeri*

Chapala
- a ***Rana megapoda***
- o ***Thamnophis melanogaster canescens***

Cofradía
- s ***Urosaurus gadovii***

Corrientes, Cape
- o ***Salvadora mexicana***

Guadalajara
- a ***Microhyla usta usta***
- a *Rana trilobata* (= ***R. pipiens trilobata***)

- o ***Adelophis copei***
- o *Cheilorhina villarsii*
- o ***Clelia clelia immaculata***
- o ***Coniophanes lateritius***
- o ***Conophis sumichrastii sumichrastii***
- o *Crotalus jimenezii* (by present restriction)
- o ***Imantodes latistratus*** (by restriction)
- o ***Sympholis lippiens***
- o ***Tantilla calamarina***
- o ***Thamnophis subcarinata subcarinata*** (by restriction)
- o ***Trimorphodon upsilon***

La Cumbre de los Arrastrados

- s ***Sceloporus asper***
- s ***Sceloporus bulleri***
- s ***Sceloporus heterolepis*** (by present restriction)

Magdalena

- s ***Sceloporus scalaris unicanthalis***
- o ***Hypsiglena affinis*** (by present restriction)
- o ***Rhadinaea hesperia hesperioides***
- o ***Sonora michoacanensis mutabilis***

San Ramón

- o ***Elaphe chlorosoma***

México

Asunción

- s ***Eumeces copei*** (10 miles southeast of)

Gavia, Hacienda de la

- s ***Barisia rudicollis*** (by present restriction)

Guadalupe, Rancho (14 kilometers east of San Martín)

- u ***Ambystoma bombypellum***
- u ***Ambystoma schmidti***

Ixtapán del Oro

- a ***Eleutherodactylus bolivari***

Lake Lerma

- u ***Siredon lermaensis***
- o ***Thamnophis melanogaster linearis***

Río Frío

- u ***Rhyacosiredon leorae***

San Juan Teotihuacán

- o *Elaphis pleurostictus* (by present restriction)
- o ***Pituophis deppei deppei*** (by present restriction)
- o *Pituophis deppei pholidostictus* (by present restriction)

San Martín

- s *Gerrhonotus adspersus* (by present restriction)

Toluca

- u ***Ambystoma granulosum*** (kilometer no. 74, about 12 miles northwest of)
- u ***Pseudoeurycea robertsi*** (Nevado de, 10,000 to 11,000 ft.)

Villa Victoria

- u ***Rhyacosiredon rivularis*** (13 kilometers west of)
- o ***Conopsis biserialis***

Zempoala
s ***Sceloporus jarrovii sugillatus*** (Laguna no. 4)
Zumpango, Lake
u ***Ambystoma lacustris***

MICHOACÁN

Apatzingán (de la Constitución)
a *Cystignathus microtis* (by present restriction)
s ***Eumeces altamirani*** (by restriction)
o ***Micrurus diastema michoacanensis*** (by present restriction)
o ***Sonora michoacanensis michoacanensis*** (by present restriction)
Cício
o ***Geophis maculiferus***
Cojumatlán
a ***Hyla smaragdina*** (6 kilometers east of)
El Mirador
u ***Ambystoma ordinarium*** (4 miles west of, near Puerto Hondo)
El Sabino (near Uruapan)
a ***Eleutherodactylus vocalis***
o ***Leptodeira bressoni***
o ***Leptodeira smithi***
o ***Leptotyphlops bressoni***
o ***Thamnophis eques postremus***
La Noria, near Zamora, Hacienda of D. Epifanio Jiménez
s ***Sceloporus dugesii intermedius***
s *Sceloporus westphalii*
Morelia
u ***Ambystoma amblycephalum*** (15 kilometers west of)
Ovopeo, 1,000 ft.
s ***Enyaliosaurus clarki***
Pátzcuaro
u ***Bathysiredon dumerilii*** (Lake)
o ***Geophis petersii*** (by present restriction)
o ***Lampropeltis ruthveni***
Quiroga
a ***Tomodactylus angustidigitorum***
Tancítaro, 6,000 ft.
o ***Pituophis deppei brevilineata***
Tangancícuaro
o ***Geophis dugesii***
Temaxcal
o ***Thamnophis vicinus***
Tengohecho
o *Erythrolamprus grammophrys*
Uruapan
a ***Microbatrachylus hobartsmithi***
o ***Trimorphodon fasciolata*** (Zararacua Falls)

MORELOS

Cuernavaca
- a ***Hyla smithi***
- a ***Hypopachus alboventer*** (8 miles east of)
- s *Cnemidophorus costatus* (by present restriction)
- s *Cnemidophorus mexicanus balsas* (by present restriction)
- s ***Cnemidophorus sackii sackii*** (by restriction)
- s ***Eumeces indubitus*** (kilometer 63)
- s ***Sceloporus horridus horridus*** (by present restriction)
- s ***Urosaurus bicarinatus bicarinatus*** (by present restriction)

Tepoztlán
- a ***Hylella azteca***

Tres Cumbres
- s ***Sceloporus aeneus aeneus*** (by present restriction)
- o ***Crotalus transversus***
- o ***Storeria storerioides*** (by present restriction)

Zempoala (Lakes of)
- u ***Pseudoeurycea altamontana***
- u ***Rhyacosiredon zempoalaensis***

NAYARIT

Acaponeta
- o ***Tantilla bogerti***

Ixtlán
- s *Cnemidophorus communis occidentalis* (by present restriction)

Miramar
- o ***Drymobius margaritiferus fistulosus***

Pedro Pablo, 2,500 ft.
- t ***Terrapene nelsoni***

San Blas
- s *Hemidactylus navarri*
- o ***Manolepis putnami***
- o ***Rhinocheilus lecontei antonii***

Tepic
- a ***Bufo nayaritensis***
- a *Hyliola digueti*
- a ***Hypopachus ovis***
- a ***Leptodactylus occidentalis***
- s ***Eumeces parvulus***
- s ***Sceloporus horridus albiventris***
- s *Sceloporus obscurus*

Tres Marías Islands
- s ***Cnemidophorus sackii mariarum***
- o ***Constrictor constrictor sigma*** (María Madre Island)
- o ***Dryadophis melanolomus slevini*** (María Madre Island)
- o ***Drymarchon corais cleofae*** (María Cleofa Island)
- o ***Exelencophis nelsoni*** (María Madre Island)
- o *Lampropeltis triangulum schmidti* (= ***L. doliata schmidti***)
- o ***Masticophis flagellum variolosus*** (María Magdalena Island)
- o ***Thalerophis diplotropis forreri***

NUEVO LEÓN

No exact locality
- o ***Lampropeltis leonis***
- o ***Tantilla atriceps***

Galeana
- u ***Pseudoeurycea galeanae*** (7,000 ft.)
- a ***Syrrhophus smithi*** (15 miles west of)
- o *Crotalus triseriatus miquihuana* (= ***C. pricei miquihuana;*** Cerro Potosí)
- o ***Rhadinaea montana*** (Ojo de Agua, near)
- o ***Tantilla wilcoxi rubricata*** (15 miles southeast of)

Montemorelos
- s *Cnemidophorus gularis meeki*

Monterrey
- a ***Syrrhophus latodactylus*** (Huasteca Cañon, 15 miles west of)
- s ***Sceloporus cyanogenys***

Pablillo, trail between Alamar and
- s ***Sceloporus torquatus binocularis***

Pesquería Grande
- s ***Cnemidophorus perplexus inornatus***
- s ***Cnemidophorus sackii octolineatus***

Sabinas Hidalgo
- s ***Sceloporus parvus parvus*** (hills 5 miles west of)
- o *Pituophis mexicanus*

Santa Caterina
- s ***Sceloporus couchii***
- o *Nerodia couchii* (by present restriction)

OAXACA

No definite locality
- a ***Eleutherodactylus rugulosus*** (Pacific region of the Isthmus of Tehuantepec) *
- s ***Abronia oaxacae***
- s *Anolis boulengerianus* (Isthmus of Tehuantepec)
- s *Anolis rubigenosus*
- s ***Barisia imbricata planifrons***
- s *Cnemidophorus unicolor* (West Tehuantepec)
- s ***Phrynosoma braconnieri***
- o ***Coluber oaxaca***
- o ***Enulius sumichrasti*** (Isthmus of Tehuantepec) *
- o *Lampropeltis triangulum oligozona* (Tehuantepec = ***L. doliata oligozona***)
- o ***Pseudoleptodeira discolor***
- o ***Salvadora bogerti*** (Tehuantepec)

Buena Vista
- o ***Rhadinaea macdougalli***

* More precise restriction is prohibited by the absence of definite records from southeastern Oaxaca where the types undoubtedly were obtained. Very likely the types were collected near Tapanatepec.

Cacoprieto
- o ***Scaphiodontophis sumichrasti***

Chihuitán
- o ***Coniophanes piceivittis***
- o ***Symphimus leucostomus***

Concordia, Cafetal, 600 m., between Puerto Ángel and Salina Cruz
- g ***Gymnopis multiplicata oaxacae***
- u ***Magnadigita macrinii***

Cuicatlán
- s ***Cnemidophorus sackii australis*** (by present restriction)
- s ***Urosaurus bicarinatus nelsoni***

Dondominguillo
- s *Ctenosaura multispinis*

El Barrio
- o ***Stenorrhina freminvillii apiata***

Guichicovi
- o ***Ficimia variegata*** (by present restriction)

Ixtepec (= San Gerónimo)
- s ***Sceloporus edwardtaylori***

Juchitán
- t ***Geoemyda rubida***
- s *Cnemidophorus lativittis*
- o ***Toluca lineata acuta***

Lachiguiri, 7,100 ft.
- s ***Gaigeia dontomasi***

La Gloria, north of Niltepec
- a ***Eleutherodactylus macdougalli***

Maquiltianguis
- u ***Thorius macdougalli*** (Cerro de Humo)

Mazatlán
- s ***Sphaerodactylus glaucus torquatus***

Mixtequilla
- o *Tantilla depressa*
- o ***Tantilla striata***

Niltapec
- s ***Ficimia ramirez*** (1 league north)

Oaxaca
- s ***Barisia gadovii levigata*** (valley of)
- s ***Barisia viridiflava*** (by restriction)
- s ***Cnemidophorus sackii bocourti*** (by present restriction)
- s ***Eumeces brevirostris*** (by present restriction)
- s *Gerrhonotus bocourti* (by present restriction)
- s *Gerrhonotus obscurus* (by present restriction)
- o ***Crotalus basiliscus oaxacus***

Pluma Hidalgo
- o ***Geophis sallaei*** (by present restriction)

Putla
- s ***Anolis nebuloides***

Quezaltepec
- s ***Anolis milleri***

Quiotepec
- o ***Trimorphodon tau***

Río Astuta
- a ***Plectrohyla brachycephala*** (at the foot of the Sierra Madre between the Sierra Madre and the Sierra Atrevesado)

Río Grande
- a ***Ptychohyla bogerti***

San Felipe, Cerro (15 kilometers northeast of Oaxaca)
- u *Bolitoglossa mexicana* (by present restriction)
- u ***Pseudoeurycea cochranae***
- u ***Pseudoeurycea unguidentis***
- u *Salamandra togata* (by present restriction)
- u ***Thorius narisovalis***
- u ***Thorius pulmonaris***
- a ***Eleutherodactylus mexicanus*** (by present restriction)
- a ***Hyla hazelae***
- a ***Hyla robustofemora***
- a ***Microbatrachylus lineatissimus*** (7,000 ft.)
- a ***Microbatrachylus oaxacae***
- o ***Crotalus gloydi*** (10,000 ft.)
- o *Thamnophis eburatus*
- o ***Toluca megalodon*** (summit of)

San José Manteca (5 kilometers from San Carlos Yautepec)
- s ***Gaigeia radula***

San Juan del Río
- t *Rhinoclemmys mexicana*

San Juan Guivini
- o ***Toluca conica***

San Luis, Cerro (15 kilometers northeast of Oaxaca)
- u ***Pseudoeurycea smithi***
- s ***Sceloporus spinosus caeruleopunctatus***

San Mateo del Mar
- a ***Microhyla usta gadovii***
- t *Cinosternum triliratum* (by present restriction)
- t ***Kinosternon cruentatum cruentatum*** (by present restriction)
- t *Kinosternum mexicanum* (by present restriction)

Santa Efigenia
- a ***Hylella sumichrasti***
- a ***Syrrhophus leprus***
- t *Claudius severus*
- t *Staurotypus marmoratus* (by present restriction)

Tapanatepec
- a ***Bufo canaliferus*** (by present restriction)
- a *Cystignathus perlaevis*
- a *Hylella platycephala*
- o ***Imantodes splendidus oliveri***
- o ***Micrurus nuchalis nuchalis***
- o ***Tantilla rubra***

Tecpan
- u ***Thorius minutissimus*** (Santo Tomás)

Tehuantepec (city, and environs)
- a *Bufo lateralis*
- a *Cystignathus fragilis*
- a ***Diaglena reticulata*** (Cerro Arenal)
- a ***Eleutherodactylus avocalis*** (Tres Cruces)
- a *Rhinophrynus rostratus*
- s ***Ameiva undulata undulata*** (by restriction)
- s ***Cnemidophorus deppii deppii*** (by restriction)
- s ***Cnemidophorus guttatus immutabilis*** (by present restriction)
- s *Cnemidophorus guttatus striatus* (by present restriction)
- s *Cnemidophorus microlepidopus* (by present restriction)
- s ***Enyaliosaurus quinquecarinatus*** (by restriction)
- s ***Lepidophyma smithi tehuanae*** (Cerro Arenal, 30 kilometers west of Tehuantepec)
- s *Phrynosoma spinimentum* (by present restriction)
- s *Sceloporus humeralis* (by present restriction)
- s ***Sceloporus melanorhinus melanorhinus*** (by present restriction)
- s ***Sceloporus siniferus siniferus*** (by present restriction)
- s ***Sceloporus variabilis smithi*** (Guengola Mt., 6 kilometers northwest of)
- s *Sphaerodactylus inornatus* (by present restriction)
- s ***Urosaurus bicarinatus anonymorphus***
- o ***Bothrops dunni***
- o ***Coniophanes imperialis copei*** (between Cerro Guengola and)
- o ***Conophis vittatus viduus***
- o ***Dipsas elegans***
- o ***Dryadophis melanolomus tehuanae*** (Cerro Guengola)
- o *Geagras longicaudatus* (by present restriction)
- o *Geagras redimitus*
- o ***Geophis dubius***
- o ***Geophis isthmicus***
- o ***Leptodeira mystacina*** (by present restriction)
- o ***Leptotyphlops phenops phenops***
- o ***Loxocemus sumichrasti***
- o ***Masticophis mentovarius mentovarius*** (by present restriction)
- o ***Micrurus ephippifer*** (by present restriction)
- o ***Oxybelis aeneus auratus*** (by present restriction)
- o ***Thalerophis diplotropis diplotropis***
- o ***Thamnophis ruthveni*** (3 miles northwest of)
- o ***Trimorphodon biscutatus biscutatus*** (by present restriction)
- o *Trimorphodon major*
- o ***Tropidodipsas macdougalli***

Tlapancingo
- s ***Gerrhonotus liocephalus liocephalus*** (by present restriction)
- s *Gerrhonotus tessellatus* (by present restriction)

Totolapam
- s ***Phyllodactylus muralis***

o *Stenorhina degenhardti quinquelineata* (by present restriction)
o ***Stenorrhina freminvillii freminvillii*** (by present resrtiction)

Totontepec
o ***Geophis anocularis***

Ventosa, Bay
t *Caretta remivaga*
s ***Gymnophthalmus sumichrasti*** (by present restriction)

Xuimygopk, between Ayutla and Cacalotepec, 8,650 ft.
o ***Toluca amphisticha***

Zempoaltepec, Mt.
s ***Abronia fuscolabialis***
s ***Sceloporus cochranae***
s ***Sceloporus siniferus cupreus*** (by present restriction)

Puebla

Alchichica, Lake
u ***Ambystoma subsalsum***

Cacaloapam
o ***Bothrops melanurus*** (by present restriction)
o *Trimeresurus garciai*

Matamoros (Izúcar)
a *Engystoma mexicanum* (by present restriction)
a *Hyla microtis*
a *Hylodes berkenbuschii* (by present restriction)
a ***Tomodactylus nitidus***
s *Cnemidophorus mexicanus* (by present restriction)
s ***Phrynosoma taurus***
o ***Leptodeira splendida***
o ***Micrurus laticollaris***
o *Tachymenis melanocephala* (by present restriction)
o ***Trimorphodon latifascia*** (by present restriction)

Necaxa
o *Lampropeltis triangulum arcifera* (by present restriction = ***L. doliata arcifera***)
o ***Tantilla morgani***

Puebla
a ***Hyla cardenasi***
s ***Sceloporus spinosus spinosus*** (by present restriction)
o *Chionactis diasii*

Río Frío, 2 miles east of
u ***Pseudoeurycea bellii*** (by present restriction)
u ***Pseudoeurycea cephalica cephalica*** (by present restriction)

Santa Caterina
s ***Sceloporus pictus***

Sierra de Zacapoaxtla
s *Gerrhonotus deppii digueti*

Tehuacán
a ***Eleutherodactylus cactorum*** (20 miles northwest at kilometer 226)
o ***Salvadora intermedia richardi*** (1 mile north of)
o ***Trimorphodon forbesi*** (San Diego)

Teziutlán
- o ***Rhadinaea quinquelineata***

QUERÉTARO

Jalpan
- s ***Lepidophyma smithi occulor***

San Juan del Río
- u ***Bathysiredon dumerilii queretarensis***

QUINTANA ROO

Catmis
- o *Thamnophis arabdotus*

Cobá
- o ***Thalerophis mexicanus yucatanensis***

Cozumel Island
- t ***Kinosternon cruentatum consors***
- s ***Anolis cozumelae***
- s *Aristelliger irregularis*
- s ***Cnemidophorus deppii cozumelus***
- s ***Sceloporus cozumelae***
- o *Eutaenia rutiloris*
- o *Thamnophis sauritus chalceus* (= ***T. sirtalis chalceus,*** by present restriction)

SAN LUIS POTOSÍ

No definite locality
- o ***Leptotyphlops humilis tenuiculus***

Álvarez
- u ***Chiropterotriton multidentata***
- s *Sceloporus pilsbryi*
- o ***Crotalus triseriatus triseriatus*** (by present restriction)
- o ***Rhadinaea gaigeae***

Arroyo Sacahuite (at Palictla, 6 miles north of Tamazunchale)
- a ***Rana moorei***

Charcas
- s ***Sceloporus goldmani***

Chijol
- t *Terrapene goldmani*

Ciudad Maiz
- o ***Oxybelis potosiensis*** (38 kilometers northwest of)

Matehuala
- s ***Sceloporus parvus scutulatus*** (30 miles north of)

San Luis Potosí
- o *Conopsis nasus heliae*
- o ***Geophis latifrontalis*** (50 miles south of)
- o ***Lampropeltis mexicana***
- o *Tantilla deviatrix* (= ***T. bocourti deviatrix***)

Xilitla (vicinity of)
- s ***Gerrhonotus liocephalus loweryi***
- s ***Xenosaurus newmanorum***
- o ***Adelphicos newmanorum*** (region)

o ***Rhadinaea marcellae***
o ***Schmidtophis rubriventris***
o ***Tantilla shawi***

SINALOA

Mazatlán
a ***Bufo kelloggi*** (2 miles east of)
a ***Bufo mazatlanensis*** (2 miles east of)
a ***Microhyla mazatlanensis*** (2 miles east of)
t ***Kinosternon hirtipes*** (by present restriction)
t ***Pseudemys scripta ornata***
s ***Anolis nebulosus*** (by present restriction)
s ***Anolis utowanae*** (10 miles north of)
s ***Callisaurus draconoides bogerti*** (Los Chivos Island in port of)
s *Ctenosaura teres brachylopha*
s ***Holbrookia maculata elegans***
o *Leptodeira personata*
o ***Leptodeira punctata*** (by present restriction)
o *Leptognathus albocinctus* (by present restriction)
o *Sphenocalamus lineolatus*
o *Tantilla bimaculata*
o ***Trimorphodon paucimaculata***
o ***Tropidodipsas philippii***
o *Tropidonotus quadriserialis*

Plomosas
s ***Sceloporus nelsoni***
o ***Crotalus stejnegeri***

Presidio de Mazatlán
a ***Diaglena spatulata***
a ***Hypopachus oxyrrhinus***
a ***Pternohyla fodiens***
a *Rana forreri*
t ***Geoemyda pulcherrima pulcherrima*** (by present restriction)
s ***Eumeces humilis***
s ***Sceloporus clarkii boulengeri***
s *Uta lateralis* (by restriction)
o *Coluber striolatus* (by present restriction)
o ***Gyalopion quadrangularis***
o ***Masticophis flagellum lineatus*** (by present restriction)

Rosario
o ***Drymarchon corais rubidus***

San Blas
o *Salvadora hexalepis celeris*

SONORA

No definite locality
s ***Phrynosoma ditmarsi*** (not far from Arizona boundary)

Mainland localities

Álamos
s ***Eumeces parviauriculatus***

- o ***Leptodeira ephippiata*** (Agua Marín, 8.3 miles west-northwest of)
- o ***Phyllorhynchus browni fortitus***

El Tigre Mountains

- s ***Sceloporus undulatus virgatus*** (Santa María Mine, in)

Guaymas

- t *Sphargis coriacea schlegelii* (by present restriction)
- s ***Cnemidophorus burti*** (La Posa, 10 miles northwest of)
- s ***Holbrookia maculata thermophila***
- s *Uta gularis*
- s ***Uta taylori*** (10 miles northwest of)
- o *Caudisona atrox sonoraensis* (by present restriction)
- o ***Chilomeniscus cinctus***
- o ***Gyalopion deserţorum*** (12 kilometers northwest of)
- o ***Masticophis bilineatus*** (by present restriction)
- o ***Micruroides euryxanthus*** (by present restriction)
- o ***Tantilla hobartsmithi*** (10 miles northwest of)
- o ***Trimorphodon lambda***

Guirocoba, 18 miles southeast of Álamos, 1,485 ft.

- t ***Pseudemys scripta hiltoni***
- t ***Terrapene klauberi***
- s ***Callisaurus draconoides brevipes***
- o ***Pseudoficimia hiltoni***

Hermosillo

- s ***Cnemidophorus tigris aethiops***
- s ***Coleonyx variegatus sonoriensis*** (5 miles southeast of)
- s ***Dipsosaurus dorsalis sonoriensis***
- s ***Phyllodactylus homolepidurus*** (5 miles southwest of)

Llano (between Nogales and Hermosillo)

- t ***Kinosternon flavescens stejnegeri***

Los Nogales

- s *Phrynosoma bufonium* (by present restriction)
- s ***Urosaurus ornatus linearis***

Puerto Libertad

- s ***Phrynosoma platyrhinos goodei*** (by present restriction)

Santa Magdalena

- s ***Urosaurus ornatus schottii***
- o ***Chionactis occipitalis palarostris*** (5 miles south of)
- o ***Diadophis regalis regalis*** (by present restriction)

Tepoca Bay

- s ***Uma notata cowlesi*** (shores of)

Zuñi

- s *Phrynosoma regale* (Sierra de la Nariz, near)

San Estéban

- s *Cnemidophorus estebanensis*
- s *Ctenosaura conspicuosa*
- s ***Sauromalus varius***

San Pedro Mártir

- s ***Cnemidophorus tigris martyris***
- s ***Uta palmeri***

San Pedro Nolasco
- s ***Cnemidophorus bacatus***
- s ***Uta nolascensis***

Tiburón
- s ***Callisaurus draconoides inusitatus***
- s *Cnemidophorus disparilis*
- s *Cnemidophorus punctilineatus*
- s ***Crotaphytus dickersonae***
- s ***Sauromalus obesus townsendi***

TABASCO

No definite locality
- t *Cinosternum berendtianum*
- t *Claudius agassizii* (by present restriction)
- t ***Claudius angustatus***
- t *Claudius megalocephalus* (by present restriction)
- s ***Laemanctus deborrei***
- o ***Dipsas maxillaris***

San Juan Bautista
- o *Scolecophis scytalinus*

Teapa
- s ***Sceloporus teapensis***
- o ***Bothrops nummifer nummifer***

Tenosique
- o *Pliocercus elapoides laticollaris* (= ***P. laticollaris***)

TAMAULIPAS

No definite locality
- a ***Bufo debilis*** (lower part of the Río Grande del Norte)
- s ***Holbrookia maculata approximans*** (lower Río Grande)

Antiguo Morelos
- o ***Micrurus fitzingeri microgalbineus*** (7 kilometers south of)

La Clementina, Hacienda, near Forlón
- o ***Hypsiglena dunklei***

Marmolejo
- s ***Eumeces dicei***

Matamoros
- u ***Diemictylus meridionalis*** (by restriction)
- a ***Scaphiopus couchii*** (by restriction)
- s ***Eumeces tetragrammus*** (by restriction)
- s *Eumeces tetragrammus funebrosus*
- o ***Coniophanes imperialis imperialis***
- o *Lampropeltis triangulum annulata* (= ***L. doliata annulata***)
- o *Zamenis conirostris*

Mier
- o ***Hypsiglena ochrorhynchus texana*** (by present restriction)

Miquihuana
- a ***Eleutherodactylus batrachylus***
- o ***Lampropeltis thayeri***

Tampico
- u ***Diemictylus kallerti***
- t ***Terrapene mexicana mexicana*** (by restriction)
- s ***Ctenosaura acanthura*** (by restriction)
- s *Cyclura shawii* (by restriction)
- s ***Cyclura teres***
- s *Iguana (Ctenosaura) armata* (by present restriction)
- s *Iguana (Ctenosaura) bellii* (by present restriction)
- s *Iguana (Ctenosaura) lanceolata* (by present restriction)
- o *Glaphyrophis lateralis*
- o ***Leptotyphlops myopicus myopicus*** (Savineto)
- o ***Natrix rhombifera blanchardi***
- c *Crocodilus biscutatus* (by present restriction)
- c *Crocodilus mexicanus*

Victoria, Ciudad
- s ***Ameiva undulata podarga*** (7 miles west of)
- o ***Pliocercus elapoides celatus***

Villagran
- o ***Agkistrodon bilineatus taylori*** (21 kilometers north west of)

TLAXCALA

Huamantla
- o ***Crotalus scutulatus salvini***

VERACRUZ

No exact locality
- s ***Anolis cymbops***
- o *Rhabdosoma guttulatum*

Acultzingo
- u ***Thorius dubitus*** (2 miles west of)
- u ***Thorius troglodytes*** (2 miles west of)
- a ***Hyla arborescandens*** (3 miles west of)
- a ***Hyla bistincta*** (Lake San Bernardino, by present restriction)
- a ***Hyla forbesi*** (3 miles west of)
- s ***Sceloporus formosus formosus*** (by present restriction)
- s ***Sceloporus mucronatus aureolus*** (2 miles west of)
- o ***Geophis blanchardi*** (2 miles west of)
- o ***Toluca lineata varians*** (by present restriction)

Alvarado
- t ***Dermatemys mawii*** (by present restriction)
- t *Emys callirostris* (by present restriction)
- t *Limnochelone micrura* (by present restriction)
- t ***Pseudemys scripta cataspila*** (by present restriction)
- t ***Staurotypus triporcatus***

Atoyac
- a ***Eleutherodactylus alfredi***
- o *Phrynonax guentheri*

Cabo Rojo, near Panaco Island
- o ***Crotalus durissus totonacus***

Cascajal, Upper Uzpanapa River
- s ***Anolis barkeri***

Castillo de Teayo
- o ***Coniophanes fissidens convergens*** (6 miles northwest of)

Cerro Gordo
- s *Gerrhonotus lemniscatus* (by present restriction)

Córdoba
- a ***Agalychnis callidryas***
- a ***Hyla euphorbiacea*** (by present restriction)
- a *Hylodes sallaei* (by present restriction)
- a ***Microbatrachylus albolabris*** (2 miles west of)
- a ***Microhyla elegans***
- a ***Smilisca baudinii baudinii*** (by present restriction)
- a *Smilisca daulinia* (by present restriction)
- s ***Iguana iguana rhinolopha*** (by present restriction)
- s ***Leiolopisma silvicolum*** (San Lorenzo, 10 miles southeast of)
- s ***Xenosaurus grandis***
- o *Boa diviniloquax mexicana* (by present restriction)
- o ***Constrictor constrictor imperator*** (by present restriction)
- o ***Drymobius margaritiferus margaritiferus*** (by present restriction)
- o ***Geophis semidoliatus*** (by present restriction)
- o ***Micrurus affinis affinis*** (by present restriction)
- o ***Pseustes poecilonotus argus*** (by present restriction)
- o ***Stenorrhina degenhardtii mexicana*** (by present restriction)
- o ***Thamnophis phenax phenax***
- o *Typhlops praelongus*

Cosamaloapam
- a ***Acrodytes spilomma***
- t *Cinosternon effeldtii* (by present restriction)
- t ***Kinosternon acutum*** (by present restriction)
- t ***Kinosternon leucostomum*** (by present restriction)
- t *Swanka maculata* (by present restriction)

Cruz Blanca
- u *Spelerpes laticeps* (by present restriction)
- s ***Sceloporus aeneus bicanthalis***
- s *Sceloporus dispar* (by present restriction)

Cuatotolapam
- g ***Dermophis mexicanus mexicanus*** (by present restriction)

Cuautlapan
- u ***Pseudoeurycea nigromaculata***
- a ***Eleutherodactylus natator***
- a ***Eleutherodactylus spatulatus***
- a ***Hyla dendroscarta***
- o ***Chersodromus liebmanni*** (by present restriction)
- o *Chersodromus nigricans* (by present restriction)
- o *Dirosema collare* (by present restriction)
- o ***Rhadinella schistosa***
- o ***Tantilla phrenitica***
- o ***Scaphiodontophis cyclurus***

Encero
- s ***Sceloporus serrifer plioporus*** (4 miles east of)

Huatusco
- a ***Syrrhophus verruculatus***
- s ***Anolis lemurinus bourgaei*** (by present restriction)
- s ***Anolis tropidonotus***
- s *Xenosaurus fasciatus*
- o *Homalocranium boulengeri*
- o *Opisthiodon torquatus*

Jalapa
- u ***Bolitoglossa platydactyla*** (by present restriction)
- u ***Parvimolge townsendi*** (Cerro de los Estropajos, near)
- u ***Pseudoeurycea gigantea***
- a ***Bufo cristatus***
- a *Bufo occipitalis* (by present restriction)
- a ***Eleutherodactylus decoratus*** (Banderilla, 6 miles west of)
- a ***Eleutherodactylus dunni*** (Cerro de los Estropajos, near)
- a ***Eleutherodactylus venustus***
- a ***Hyla miotympanum*** (by present restriction)
- a *Hyla nigropunctata*
- a ***Hyla picta***
- a ***Hyla taeniopus***
- a *Hylodes plicatus*
- a *Syrrhophus mystaceus* (Cerro de los Estropajos, near)
- s ***Anelytropsis papillosus***
- s ***Anolis laeviventris*** (by present restriction)
- s *Anolis sallaei* (by present restriction)
- s ***Anolis sericeus*** (El Encero de)
- s *Anolis wiegmanni* (by present restriction)
- s ***Celestus enneagrammus***
- s *Corythophanes chamaeleopsis* (by present restriction)
- s ***Corythophanes hernandezii*** (by present restriction)
- s *Corythophanes mexicanus* (by present restriction)
- s ***Eumeces lynxe furcirostris***
- s ***Laemanctus longipes***
- s ***Sceloporus jalapae***
- s ***Sceloporus malachiticus salvini*** (by restriction)
- o ***Coniophanes fissidens proterops***
- o ***Crotalus durissus durissus*** (by present restriction)
- o *Elapochrous deppei* (by present restriction)
- o *Geophis fuscus*
- o *Lampropeltis triangulum polyzona* (Cuatupe, near) (= ***L. doliata polyzona***)
- o ***Leptodeira frenata***
- o ***Leptodeira maculata*** (5 miles east of, by present restriction)
- o *Liophis tricinctus* (by present restriction)
- o ***Micrurus elegans elegans*** (by present restriction)
- o ***Pituophis deppei lineaticollis***
- o ***Pliocercus elapoides elapoides***
- o ***Thamnophis scalaris scalaris***

Jicaltepec
- o ***Adelphicos quadrivirgatus quadrivirgatus*** (by present restriction)

o *Adelphicos quadrivirgatus acutirostrum* (by present restriction)
o *Coluber sibon* (by present restriction)
o ***Sibon nebulatus*** (by present restriction)
o ***Storeria dekayi temporalineata*** (San Rafael)

Jico (Xico)
a *Hyla proboscidea* (2 miles west of) (= ***Hyla dalquesti***)

La Joya
u ***Chiropterotriton lavae*** (2 miles west of)

La Laja
t ***Kinosternon herrerai***

Metlac
u ***Oedipina lineola*** (by present restriction)
u *Spelerpes infuscatus* (by present restriction)

Mirador
u ***Chiropterotriton chiroptera***
a *Hyla gracilipes*
a *Hyla muricolor*
s *Sceloporus heterurus*
s ***Sceloporus mucronatus mucronatus***
s *Sceloporus viviparus*
o ***Bothrops nummifer veraecrucis***
o *Coluber novae hispaniae* (by present restriction)
o *Galedon annularis* (by present restriction)
o ***Imantodes cenchoa leucomelas***
o *Leptognathus dumerili* (by present restriction)
o *Spilotes pullatus auribundus*
o ***Spilotes pullatus mexicanus*** (by present restriction)
o *Spilotes variabilis* (by present restriction)
o ***Tantilla miniata***
o ***Tropidodipsas sartorii sartorii***

Misantla
a *Hyla godmani* (by present restriction)

Orizaba
u ***Bolitoglossa rufescens***
u ***Pseudoeurycea leprosa***
u *Spelerpes gibbicaudus*
u *Spelerpes orizabensis* (Mount)
u ***Thorius pennatulus***
a ***Eleutherodactylus beatae*** (La Perla, near)
a ***Eleutherodactylus rhodopis*** (by restriction)
a ***Hyla staufferi***
s ***Abronia taeniata graminea***
s ***Barisia antauges***
s ***Barisia modesta*** (by present restriction)
s ***Corythophanes cristatus*** (by present restriction)
s *Diploglossus chalybeus*
s ***Gerrhonotus liocephalus ophiurus***
s ***Laemanctus serratus*** (Valley of)
s ***Leiolopisma gemmingeri***
s ***Phrynosoma orbiculare cortezii*** (Hacienda del Jasmin, between Córdoba and)

- o ***Bothrops undulatus*** (by present restriction)
- o ***Drymarchon corais orizabensis***
- o *Elaps corallinus crebripunctatus* (by present restriction) *
- o ***Ficimia olivacea*** (by present restriction)
- o ***Leptodeira annulata taylori***
- o ***Ninia diademata diademata***
- o ***Rhadinaea fulvivittis*** (Alpine region of)
- o ***Rhadinaea vittata*** (by present restriction)
- o ***Storeria dekayi anomala***
- o *Streptophorus bifasciatus* (by present restriction)
- o ***Thamnophis chrysocephalus***
- o ***Thamnophis sumichrasti sumichrasti***
- o ***Typhlops basimaculatus*** (by present restriction)
- o *Typhlops perditus*

Pan de Olla (south of Tezuitlán)

- a ***Hyla pachyderma***
- o ***Toluca lineata wetmorei***

Perez

- s ***Cnemidophorus deppii oligoporus***

Potrero Viejo

- a ***Hyla rickardsi***
- a ***Leptodactylus labialis*** (by present restriction)
- a ***Syrrhophus cystignathoides***
- s ***Eumeces sumichrasti*** (by restriction)
- s ***Leiolopisma cherriei stuarti***
- o ***Coniophanes imperialis clavatus*** (by present restriction)
- o ***Oxyrhopus baileyi***
- o ***Rhadinaea decorata*** (by present restriction)
- o ***Scaphiodontophis nothus***
- o ***Thalerophis mexicanus mexicanus*** (by present restriction) *

Puerto México

- a *Bufo eiteli*
- o *Calopisma quinquevittatum mexicana* (by present restriction)
- o *Hydrops lubricus* (by present restriction)

Rodríguez Clara

- a ***Microbatrachylus pygmaeus***
- o *Liophis varia* (by present restriction)

San Andrés Tuxtla

- s ***Ameiva undulata amphigramma***
- o ***Coniophanes fissidens fissidens*** (by present restriction)

San José Acateno

- o ***Geophis longiceps***

San Lorenzo

- o ***Ficimia publia taylori***

Tecolutla

- s ***Holbrookia propinqua piperata*** (2 miles south of)

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* No specimens are definitely known from the state of Puebla.

* *Leptophis mexicanus mexicanus* Smith and Taylor, Bull. U. S. Nat. Mus., no. 187, 1945, p. 91.

Tequeyutepec (7 miles west of Jalapa)
- a ***Eleutherodactylus dorsoconcolor***
- o ***Rhadinaea forbesi***

Totalco
- u ***Pseudoeurycea melanomolga*** (20 kilometers north of)
- s ***Sceloporus megalepidurus***
- o ***Crotalus gloydi lautus***
- o ***Sistrurus ravus*** (by present restriction)
- o ***Thamnophis eques eques*** (by present restriction)

Tuxpan
- o ***Pliocercus bicolor***

Tuxpango (near Orizaba)
- o ***Trimorphodon collaris***

Veracruz
- a ***Bufo marmoreus***
- a ***Bufo horribilis***
- a *Bufo trachypus* (by present restriction)
- a ***Bufo valliceps*** (by present restriction)
- a ***Rana pipiens austricola*** (by restriction)
- a ***Rhinophrynus dorsalis***
- t *Emys berardii*
- s *Anolis jacobi* (by present restriction)
- s ***Basiliscus vittatus*** (by present restriction)
- s ***Cnemidophorus guttatus guttatus*** Wiegmann (by present restriction)
- s *Ctenosaura cycluroides* (by present restriction)
- s *Cyclura denticulata* (by present restriction)
- s *Cyclura semicristata* (by present restriction)
- s ***Sceloporus variabilis variabilis*** (by present restriction)
- o ***Conophis lineatus lineatus*** (by present restriction)
- o ***Ninia sebae sebae*** (by present restriction)
- o *Streptophorus sebae collaris* (by present restriction)
- c *Crocodilus americanus* (by present restriction)

Xometla (8,500 ft., Mt. Orizaba)
- u ***Pseudoeurycea gadovii***

Zacuapán
- o ***Dryadophis melanolomus veraecrucis***
- o *Eudryas boddaerti mexicanus*

YUCATÁN

No specific locality
- u ***Bolitoglossa yucatana***
- a ***Eleutherodactylus laticeps***

Chichen Itzá
- a ***Triprion petasatus*** (by present restriction)
- t ***Kinosternon creaseri*** (1 mile south of Hacienda)
- t ***Terrapene mexicana yucatana*** (by present restriction)
- s *Anolis aureolus* (by present restriction)
- s ***Anolis beckeri*** (by present restriction)
- s ***Cnemidophorus sackii angusticeps*** (by present restriction)

- s ***Enyaliosaurus defensor*** (by present restriction)
- s ***Leiolopisma cherriei ixbaac***
- s *Norops yucatanicus*
- s ***Sceloporus chrysostictus*** (by present restriction)
- s ***Thecadactylus rapicaudus*** (by present restriction)
- o ***Bothrops yucatanicus***
- o *Cochliophagus tornieri* (by present restriction)
- o ***Coniophanes schmidti***
- o ***Conophis lineatus concolor*** (by present restriction)
- o *Dipsadomorus fasciatus* (by present restriction)
- o ***Dipsas brevifacies*** (by present restriction)
- o ***Dipsas sanniolus*** (by present restriction)
- o ***Dryadophis melanolomus melanolomus*** (by present restriction)
- o *Drymarchon corais melanocercus* (by present restriction)
- o ***Drymarchon corais melanurus*** (by present restriction)
- o ***Elaphe flavirufa flavirufa*** (by present restriction)
- o *Ficimia ornata* (by present restriction)
- o ***Ficimia publia*** (by present restriction)
- o *Gcophis multitorques yucatanicus*
- o ***Imantodes splendidus splendidus*** (by present restriction)
- o ***Imantodes tenuissimus*** (by present restriction)
- o *Lampropeltis triangulum blanchardi* (= ***L. doliata blanchardi***)
- o ***Leptodeira yucatanensis yucatanensis*** (by present restriction)
- o *Leptognathus leucostomus* (by present restriction)
- o *Leptognathus subannulatus* (by present restriction)
- o *Leptognathus torquatus* (by present restriction)
- o ***Micrurus affinis mayensis***
- o ***Ninia sebae morleyi***
- o ***Oxybelis fulgidus*** (by present restriction)
- o ***Pliocercus elapoides schmidti***
- o ***Tantilla canula*** (by present restriction)
- o ***Tropidodipsas fasciata*** (by present restriction)
- o ***Typhlops microstomus*** (by present restriction)

Citilpech

- s *Anolis acutirostris*

Dzitás

- o ***Opheodrys mayae***

Libre Unión

- o ***Pliocercus andrewsi***

Mérida

- s ***Anolis kidderi***
- s ***Laemanctus alticoronatus***
- s ***Sceloporus lundelli gaigeae***
- s ***Sceloporus serrifer serrifer*** (by present restriction)
- s ***Sphaerodactylus glaucus glaucus***
- o ***Coniophanes meridanus***
- o ***Tantilla cuniculator***

Progreso
s ***Ameiva undulata gaigeae***
s *Hemidactylus exsul*

ZACATECAS
Hacienda El Florencio
a ***Eleutherodactylus occidentalis***
La Colorada
o ***Crotalus molossus nigrescens*** (4 miles west of)
Valparaiso Mts.
s ***Sceloporus jarrovii minor*** (by present restriction)

UNITED STATES

ARIZONA
Apache County
Springerville, 11 miles south of
a ***Hyla wrightorum***
Cochise County
Chiricahua Mts.
s ***Urosaurus ornatus chiricahuae*** (Pinery Canyon)
Fairbank
s *Cnemidophorus arizonae*
Huachuca Mts.
s ***Holbrookia maculata pulchra*** (Carr Canyon, 5,200 ft.)
s ***Sceloporus jarrovii jarrovii*** (by present restriction)
s ***Sceloporus scalaris slevini*** (Miller Peak)
o ***Crotalus lepidus klauberi*** (Carr Canyon)
o *Crotalus triseriatus pricei* (= ***C. pricei pricei***)
o ***Crotalus willardi*** (Ramsey Canyon; by present restriction)
o ***Tantilla wilcoxi wilcoxi*** (Fort Huachuca)
Coconino County
Painted Desert, Little Colorado River
s ***Crotaphytus collaris baileyi***
Gila County
Tonto Creek, 6,000 ft.
o ***Thamnophis rufipunctatus***
Graham County
Camp Grant
o *Bascanium semilineatus* (by present restriction)
o ***Masticophis flagellum piceus***
Gila Mts.
s ***Sauromalus obesus tumidus*** (Telegraph)
Maricopa County
Wickenburg
o ***Crotalus scutulatus scutulatus*** (by present restriction)
Mohave County
Fort Mojave, between Fort Yuma and, along the Colorado River near 35° N.
a *Bufo frontosus*

Navajo County
Winslow, 10 miles east of
o ***Arizona elegans philipi***
Pima County
Fort Buchanan (4 miles south of Tucson)
o ***Gyalopion canum***
o *Hypsiglena chlorophaea*
Indian Oasis, 27 miles west of
o ***Lampropeltis getulus yumensis***
Santa Catalina Mts.
o *Diadophis regalis arizonae* (Sabino Canyon)
Sasabe
o ***Crotalus tigris***
Sierra de Morena (= Sierra de la Union, 10 miles southwest of San Miguel)
s ***Heloderma suspectum***
Tucson
t *Cinosternum punctatum* (by present restriction)
t ***Kinosternon sonoriense***
s ***Callisaurus draconoides ventralis*** (by present restriction)
o ***Diadophis regalis laetus*** (by restriction)
o ***Phyllorhynchus browni browni***
o *Pituophis catenifer rutilis*
o *Thamnophis macrostemma megalops* (= ***T. subcarinatus megalops***) (by present restriction)
Xavier
s ***Coleonyx variegatus bogerti***
o ***Phyllorhynchus decurtatus nubilis*** (Weisner's Ranch)
Santa Cruz County
Calabasas Canyon (4 miles north of Mexican border, south of Calabasas)
o *Oxybelis microphthalmus*
Santa Rita Mts.*
a *Hyla affinis*
a ***Hyla arenicolor*** (by present restriction)
s ***Sceloporus clarki clarki*** (by present restriction)
o ***Lampropeltis getulus splendida*** (by present restriction)
o ***Salvadora grahamiae*** (by present restriction)
o ***Sonora semiannulata semiannulata*** (by restriction)
Yavapai County
Canyon Prieto
o ***Crotalus mitchellii pyrrhus***
Fort Whipple
o ***Lampropeltis pyromelana***
o ***Salvadora hexalepis hexalepis***
o ***Sonora semiannulata isozona***

* While the type localities of all forms listed for this locality were originally stated as "Sonora," with little doubt the specimens actually were secured in the part of Arizona that was only long ago part of Sonora. Stickel (Proc. Biol. Soc. Wash., vol. 56, 1943, p. 120) provides reasonable evidence for justification of his restriction of the type locality of *Sonora s. semiannulata* to the vicinity of the Santa Rita Mountains. We believe it equally reasonable to so restrict the other names here cited.

Yuma County
Yuma
a ***Bufo alvarius*** (by present restriction)
s *Cnemidophorus gracilis* (by present restriction)
s *Cnemidophorus melanostethus* (by present restriction)
s ***Phrynosoma solare*** (by present restriction)
s ***Sceloporus magister magister*** (Fort Yuma)
s ***Uma notata notata*** (by present restriction)
s *Uma rufopunctata*

ARKANSAS
No specific locality
o ***Elaphe laeta laeta*** (Red River)
o ***Thamnophis marciana*** (Red River)
Lawrence County
Imboden
u ***Siren intermedia nettingi***

CALIFORNIA
No specific locality
s *Crotaphytus gambelii*
s *Eumeces skiltonianus amblygrammus* (Fort Humboldt)
o ***Masticophis lateralis***
El Dorado County
No specific locality
o *Lampropeltis getulus boylii*
Fresno County
Fort Miller
s *Cnemidophorus tigris mundus*
s *Cnemidophorus undulatus*
Fresno
o ***Tantilla eiseni eiseni***
Imperial County
Holtville
o ***Chionactis occipitalis annulatus*** (by present restriction)
Seeley
o ***Sonora semiannulata linearis***
Winterhaven (= Fort Yuma, Camp Yuma)
s ***Coleonyx variegatus variegatus***
s ***Dipsosaurus dorsalis dorsalis***
s ***Phrynosoma m'callii*** (between Vallecita and)
s ***Sauromalus obesus obesus***
s ***Urosaurus graciosus***
s ***Urosaurus ornatus symmetricus***
Inyo County
Death Valley
s *Anota calidiarum*
Kern County
El Paso Creek
s ***Sceloporus occidentalis biseriatus*** (borders of, by present restriction)

Fort Mohave, Mountains near
t ***Gopherus agassizii***
Fort Tejon
u ***Ensatina croceater***
s ***Xantusia vigilis***
Randsburg
o ***Lichanura roseofusca gracia***
Tehachapi Mountains
s ***Eumeces gilberti rubricaudata***
Los Angeles County
Pasadena, Arroyo Seco Canyon
s ***Uta stansburiana hesperis***
Monterey County
Monterey
u ***Aneides lugubris lugubris***
Orange County
Lower Coyote Creek, near Alamitos
t ***Clemmys marmorata pallida***
San Benito County
Bear Valley
s ***Phrynosoma coronatum frontale***
San Bernardino County
Mojave River
s *Eumeces quadrilineatus* (by present restriction)
San Diego County
Boulder Creek
u ***Taricha klauberi***
Coast Range, summit of
s ***Sceloporus graciosus vandenburgianus***
s ***Streptosaurus mearnsi*** (at boundary of United States and Mexico)
Deerhorn Flat
o ***Salvadora hexalepis virgultea***
Dry Lake, Bensons
o ***Arizona elegans eburnata***
o ***Phyllorhynchus decurtatus perkinsi***
Dulzura
o ***Crotalus ruber*** (by present restriction)
La Jolla
o ***Arizona elegans occidentalis***
Milquatay Valley
s ***Sceloporus orcutti orcutti***
Mountain Spring, Colorado Desert
o *Bascanion flagellum frenatum*
Narrows, The
o ***Crotalus cerastes laterorepens***
o ***Rhinocheilus antonii clarus*** (Borego Valley, 2 miles north of)
Poway
s *Xantusia picta* (by present restriction)

Proctor Valley, between Jamul and Upper Otay Reservoir
s ***Coleonyx variegatus abbotti***
San Diego
s ***Anniella pulchra pulchra*** (by present restriction)
s *Anniella texana* (by present restriction)
s ***Elgaria multicarinata webbii*** (by restriction)
s ***Phrynosoma coronatum blainvillii*** (by present restriction)
o *Coronella multifasciata* (by present restriction)
o ***Diadophis amabilis similis***
o *Lampropeltis californiae* (= ***Lampropeltis getulus californiae***) (by present restriction)
o ***Pituophis catenifer annectens***
o ***Rhinocheilus lecontei lecontei***
o *Thamnophis hammondii* (= ***T. elegans hammondii***) (by restriction)
Vallecito, 35 miles west of
o ***Leptotyphlops humilis humilis*** (by present restriction)
Wildwood Ranch, 1,520 ft. (5 miles southwest of Ramona)
o ***Trimorphodon vandenburghi***
Witch Creek, 2,700 ft.
s ***Xantusia henshawi***
Yaqui Well
o ***Leptotyphlops humilis cahuilae***
o ***Tantilla eiseni transmontanus*** (1 mile east of)
San Francisco County
San Francisco
a ***Rana aurora draytoni*** (by present restriction)
Santa Barbara County
Santa Barbara
o ***Lampropeltis zonata zonata***
Shasta County
Fort Reading (near Redding)
a ***Scaphiopus hammondii***
Solano County
Benicia
a ***Bufo boreas halophilus***
Ventura County
Santa Paula, 800 ft.
a ***Bufo californicus***

COLORADO
Fremont County
Beaver Creek
s ***Cnemidophorus tesselatus***
Larimer County
Cow Creek
s ***Eumeces multivirgatus***
Prowers County
Arkansas River
a ***Bufo cognatus***

Pueblo County
Pueblo
o ***Masticophis flagellum testaceus*** (by present restriction)

FLORIDA
Monroe County
Key West
t ***Lepidochelys kempii*** (by present restriction)

INDIANA
Posey County
New Harmony, Fox River at
t ***Pseudemys scripta elegans***

IOWA
Pottawatomie County
Council Bluffs
t ***Terrapene ornata*** (by present restriction)

KANSAS
Cowley County
Winfield
o ***Sistrurus catenatus tergeminus*** (by present restriction)
Geary County
Fort Riley
a ***Microhyla olivacea*** (by present restriction)
s ***Phrynosoma cornutum*** (by present restriction)
s *Phrynosoma harlanii* (by present restriction)
Riley County
Manhattan
t ***Chrysemys picta bellii*** (by present restriction)

LOUISIANA
Orleans Parish
New Orleans
t ***Chelydra serpentina*** (by present restriction)

MISSOURI
Cape Girardeau County
Cape Girardeau, below, on Mississippi River
s ***Leiolopisma laterale***
Jasper County
Carthage
o ***Pituophis catenifer sayi*** (by present restriction)

MONTANA
Chouteau County
Fort Benton
a *Bufo dipternus* (by present restriction)

NEBRASKA
Boyd County
Gross
o ***Crotalus viridis viridis*** (by present restriction)

Washington County
Boyers River, stone quarry on west side of Missouri River three miles above the mouth of
o *Thamnophis sauritus proximus* (= ***T. sirtalis proximus***)
o *Thamnophis sirtalis parietalis* (= ***T. ordinatus parietalis***)

NEW JERSEY
Gloucester County
Raccoon
a ***Rana pipiens***

NEW MEXICO
No definite locality
u *Siredon harlanii* (Spring Lake)
t *Cinosternum henrici*
Dona Ana County
Jornada del Muerto
s *Crotaphytus fasciatus*
s *Lamprosaurus guttulatus*
Valley, 20 miles northeast of Fort Cummings
s *Holbrookia maculata flavilenta*
Las Cruces
s ***Phrynosoma modestum*** (by present restriction)
Grant County
Fort Webster
s ***Elgaria kingii nobilis*** (Copper mines of the Gila)
o ***Crotalus molossus molossus*** (Santa Rita del Cobre)
McKinley County
Zuñi
o ***Pituophis catenifer affinis***
Otero County
Alamogordo
s ***Uta stansburiana stejnegeri*** (mouth of dry canyon)
San Juan County
Pueblo Bonito
s *Cnemidophorus gularis velox* (by present restriction)
Shiprock
o ***Masticophis taeniatus taeniatus*** (by present restriction)
Santa Fe County
Santa Fe
s ***Gambelia wislizenii wislizenii***
s ***Phrynosoma douglassii hernandezi*** (by present restriction)
Sierra County
Lake Valley
o ***Leptotyphlops myopicus dissectus***

NEW YORK
Albany County
Albany
a ***Acris crepitans*** (by present restriction)

OKLAHOMA
- Beckham County
  - Suydam Creek
    - s ***Sceloporus undulatus consobrinus*** (junction with north fork of Red River)
- Garvin County
  - Maysville
    - o *Psammophis flavigularis* (by present restriction)
- Tulsa County
  - Tulsa
    - o ***Natrix erythrogaster transversa*** (by present restriction)
    - o ***Natrix rhombifera rhombifera*** (by present restriction)

OREGON
- Wasco County
  - The Dalles
    - s ***Eumeces skiltonianus*** (by present restriction)
    - o ***Crotalus viridis oreganus*** (by present restriction)

SOUTH CAROLINA
- Charleston County
  - Charleston
    - a ***Rana catesbeiana*** (by present restriction)
    - t *Testudo cephalo* (by present restriction)
    - t *Testudo viridis* (by present restriction)
    - s ***Cnemidophorus sexlineatus*** (by present restriction)
    - o ***Opheodrys aestivus*** (vicinity of; by present restriction)

TENNESSEE
- Hardeman County
  - Boliver, 10 miles northeast of
    - o ***Agkistrodon piscivorus leucostomus*** (by restriction)

TEXAS
- Aransas County
  - Rockport
    - t ***Malaclemys terrapin littoralis***
- Atascosa County
  - Pleasanton, 9 miles east of
    - o *Tantilla kirnia*
    - o ***Tantilla nigriceps fumiceps*** (by restriction)
  - Somerset, 9 miles southwest of
    - s ***Holbrookia propinqua*** (by present restriction)
- Bexar County
  - Helotes
    - a ***Eleutherodactylus latrans***
    - s ***Coleonyx brevis***
    - s ***Eumeces brevilineatus***
  - San Antonio
    - u ***Ambystoma tigrinum proserpine*** (Salado River, 4 miles east of)
    - a *Bufo nebulifer* (by present restriction)

t ***Pseudemys floridana texana***
s ***Sceloporus variabilis marmoratus***

Brewster County
Boquillas, on Rio Grande River
t ***Pseudemys scripta gaigeae***
Chalk Draw
o ***Leptotyphlops humilis segregus***
Chisos Mts.
s ***Sceloporus merriami annulatus*** (east slope of)
o *Agkistrodon mokeson pictigaster* (= ***A. contortrix pictigaster***) (Maple Canyon, 5,200 ft.)
o *Diadophis regalis blanchardi* (the Basin)
o ***Salvadora hexalepis deserticola*** (Government Spring)
o ***Sonora semiannulata blanchardi*** (northern slopes of)

Calhoun County
Indianola
o ***Crotalus atrox***

Cameron County
Brownsville
a ***Bufo compactilis speciosus*** (by present restriction)
a *Hyla vanvlietii*
a ***Syrrhophus campi***
t ***Amyda emoryi*** (Rio Grande River)
t ***Gopherus berlandieri*** (by present restriction)
s *Cnemidophorus guttatus* Hallowell (by present restriction)
s ***Cnemidophorus sackii gularis*** (by present restriction)
o ***Coluber constrictor stejnegerianus*** (by present restriction)
o ***Heterodon nasicus kennerlyi*** (by present restriction)
o ***Leptodeira annulata septentrionalis*** (by present restriction)
o ***Masticophis taeniatus ruthveni***

Comal County
New Braunfels
s ***Holbrookia texana***
o ***Micrurus fulvius tenere*** (by present restriction)

Comanche County
Comanche
o ***Leptotyphlops dulcis*** (by present restriction)

Duval County
San Diego
a ***Hypopachus cuneus cuneus***
s *Cnemidophorus gularis sericeus*
s *Lysoptychus (Sceloporus) lateralis*
o ***Sonora taylori*** (by present restriction)

El Paso County
El Paso
a *Hyla copii*
s *Cnemidophorus marmoratus* (by present restriction)
s *Phrynosoma planiceps* (by present restriction)

Fort Bliss
o ***Tantilla nigriceps nigriceps*** (by present restriction)
Erath County
No definite locality
s ***Holbrookia maculata lacerata*** (by present restriction)
Hidalgo County
Hidalgo
s ***Sceloporus grammicus disparilis*** (Lomita Ranch, 6 miles north of)
Jeff Davis County
Davis Mountains
o *Elaphe sclerotica*
o ***Elaphe subocularis***
o ***Lampropeltis alterna***
Fort Davis
s *Cnemidophorus grahami* (by present restriction)
s ***Urosaurus ornatus schmidti***
o *Coluber taeniatus girardi* (by present restriction)
o ***Elaphe bairdi***
o ***Masticophis taeniatus ornatus*** (by present restriction)
Kendall County
Edge Falls, 4 miles south of Kendalia
o ***Storeria dekayi texana***
Kleburg County
Kingsville
o ***Salvadora lineata***
McLennan County
Waco
t ***Kinosternon flavescens flavescens*** (by present restriction)
Maverick County
Eagle Pass
o ***Arizona elegans elegans*** (by present restriction)
o *Coluber arizonae* (by present restriction)
o ***Drymarchon corais erebennus***
o *Drymarchon corais obsoleta*
o ***Masticophis taeniatus schotti***
o ***Sonora episcopa*** (by present restriction)
Presidio County
Marfa
s *Cnemidophorus septemvittata* (by present restriction)
Presidio (del Norte)
o ***Crotalus lepidus lepidus*** (by present restriction)
Starr County
Rio Grande City
s ***Sceloporus olivaceus*** (Arroyo Los Olmos, 3 miles southeast of)
o ***Ficimia streckeri*** (Arroyo Los Olmos, 3 miles southeast of)

Val Verde County
Devils River (Rio San Pedro)
a ***Bufo punctatus***
s ***Cnemidophorus perplexus perplexus***
s ***Eumeces obsoletus***
s ***Gerrhonotus liocephalus infernalis***
s *Holbrookia affinis*
s ***Sceloporus poinsettii***
s ***Urosaurus ornatus ornatus*** (by restriction)
East Painted Cave, near mouth of Pecos River
s ***Sceloporus merriami merriami***
Webb County
Laredo
s ***Crotaphytus reticulatus*** (by present restriction)

UTAH

Salt Lake County
Great Salt Lake
s ***Cnemidophorus tigris tigris*** (valley of)
s ***Phrynosoma platyrhinos platyrhinos***
Washington County
Beaverdam Mountains
o ***Pituophis catenifer deserticola*** (by restriction)

WASHINGTON

King County
Seattle
a ***Hyla regilla*** (by present restriction)

SOUTH AMERICA

ARGENTINA

Buenos Aires
o *Bothrops atrox dirus*

BRAZIL

Amazon River
a ***Hyla lichenosa*** (by present restriction)
a ***Rana palmipes***
Espíritu Santo River
o *Oxybelis acuminatus*
Río de Janeiro
s *Scincus agilis*

COLOMBIA

No definite locality
o ***Bothrops schlegelii***
Baranquilla
s *Anolis sulcifrons*
s *Goniodactylus braconnieri*
Río Magdalena
c ***Caiman crocodilus fuscus***

Río Truando
a ***Engystomops pustulosus***
s ***Anolis pentaprion***
Turbo
a ***Hyla phaeota***

DUTCH GUIANA

No definite locality
o ***Clelia clelia clelia***

ECUADOR

No definite locality
a *Bufo intermedius* (Andes)
Guayaquil
o *Pseudodipsas fallax* (by present restriction)

URUGUAY

Montevideo
o ***Erythrolamprus bizona*** (by present restriction)

VENEZUELA

No definite locality
a *Bufo sternosignatus*
Caracas
o *Comastes quincunciatus*

WEST INDIES

CUBA

Cienfuegos
s ***Anolis sagrei sagrei*** (by present restriction)

JAMAICA

No definite locality
t *Testudo caouana* (by present restriction)

ST. VINCENT

No definite locality
s ***Hemidactylus mabouia*** (by present restriction)
s ***Mabuya mabouya mabouya*** (by present restriction)

SANTO DOMINGO

Puerto Plata
c ***Crocodylus acutus acutus*** (by present restriction)

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Anomalies Found in a Series of Fetal and Newborn Puppies

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ABSTRACT: Anomalies occurring in a series of 176 fetal and newborn puppies are reported. The anomalies are grouped under three categories: hernias; abnormally-shaped organs; and absence of organs. There are three cases of hernia; five cases in which the thyroid and two in which the spleen has an abnormal shape; there is one case in which the urinary bladder is absent, and two in which one of the paired gonads is absent.

A series of 176 fetal and newborn puppies has been used in studying the growth of the various organs, and several anomalies have been observed and recorded. A record of these, and also the relative incidence of the various types of anomalies, may be of interest, hence this report is being presented.

There were 152 fetal and 24 newborn puppies in this series. They were all obtained from the dogs used in the Physiology Department and consequently were of all breeds, or rather, most of the dogs were of no breed, being mongrels. None of the fetuses were taken from dogs used in prolonged physiology experiments, which might affect the development of the fetuses. The newborn puppies were found at the animal house in the morning, having been born some time during the night. These newborns were chloroformed and then treated in the same manner as the fetuses. All of the specimens were preserved in an adequate amount of 10 percent formalin after the abdominal and the thoracic cavities had been filled with a 10 percent solution of formalin. Only enough formalin was injected into these cavities, using a hypodermic syringe, to moderately fill the cavity. Then an opening through the skin, fascia and brain

case was made at the top of the skull so that the fluid might enter and preserve the brain and spinal cord. They were left in the formalin solution for at least two months so that they might be completely fixed and the evidence (Donaldson, '94; Hrdlicka, '06; Kato, '38) seems to indicate that the changes, whatever they may be, have become stabilized after this length of time in the preservative.

There were 36 litters, with from 1 to 9 in each litter, or an average of 4.89 puppies per litter. There were 6 litters of newborns and they averaged just 4 puppies per litter. There were 86 of each sex and 4 were so small that their sex could not be determined positively in the gross dissection. They ranged from 3 to 494 grams in body weight and from 55 to 257 mm. in body length. The heaviest fetus weighed 410 grams, but the longest specimen was a fetal dog.

Each specimen was removed from the formalin solution, all excess liquid removed with paper toweling and then weighed on a laboratory balance to the nearest tenth of a gram for the larger specimens and on a chemical balance to the nearest milligram for the smaller specimens. These smaller specimens, as well as the organs, were weighed in a glass stoppered weighing bottle to prevent drying during the weighing. The lengths are the nose-anus lengths measured along the back of the puppy. In the larger litters, where the fetuses were crowded, they were much more curved than in those litters with few and widely separated fetuses.

A regular routine of dissection was followed as described in an earlier paper (Latimer and Corder, '48). When these anomalies were found they were studied and recorded on the backs of the record cards. It has seemed of some value to collect these and find out some of the more common variations found in a series of fetal and newborn dogs.

These anomalies may be grouped in three categories: (*a*) hernias; (*b*) absence of organs and (*c*) abnormally shaped organs.

HERNIAS

In these 176 specimens three hernias were found, one umbilical, one diaphragmatic and one through the muscular lacuna. This last, a most unusual hernia has been described (Latimer, '48) and it will not be described again. A diligent search of the literature has revealed no case similar to this, described either in man or in any of the domestic animals. This was a hernia of approximately one-third of the length of the small intestine through the muscular lacuna. The herniated mass seemed to have followed the course of

the psoas major muscle out into the medial side of the thigh. Another hernia, also in a male fetus of 7.268 grams of body weight, was a typical umbilical hernia. Only about two cm. of the small intestine had herniated out through the umbilical opening whose edges were rounded and not closely pressed on the hernia or the umbilical vessels. The third hernia was found in a 262.3 gram female fetus. In this case the entire spleen had passed under the left lateral lumbocostal arch into the left thoracic cavity. The vessels were attached in a normal manner to the spleen and their other connections were all normal except their length which was increased, of course, due to the position of the spleen up in the thoracic cavity. These last two types are found both in man and in the domestic animals and they need no further discussion. Three cases of hernia in 176 specimens gives an incidence of 1.7 percent for this series of puppies.

One thing noticed in the handling and dissection of all of these specimens was that the tension of the abdominal wall was much greater than that of the thoracic wall. In both the fetuses and also in the newborn pups the abdominal cavity was full while the thoracic cavity was not filled completely. Even in the early newborn specimens the lungs had not completely filled the thoracic cavities. In these specimens the abdominal cavity appeared to be more than full and in three of these there had been a herniation or protrusion of a viscus from this cavity.

ABNORMAL SHAPE

The most common variation was the shape of the thyroid gland. In these dogs there were usually two separate and distinct lobes lying on either side of the trachea and in no way connected by thyroid tissue. In five of these dogs, one male and four females, the inferior or caudal ends of these paired lobes were connected by an isthmus or a median mass of thyroid tissue thus resembling the shape of the human thyroid gland. These specimens with the two lobes of the thyroid connected by an isthmus ranged in body weight from 8.624 to 220.5 grams of body weight. One female with a body weight of 203.7 was a newborn puppy. Bradley ('43) describes the thyroid as consisting of two lobes and "an isthmus of variable dimensions." He later says "Frequently the isthmus is absent." The isthmus was present in but five of the 176 or in but 2.84 percent of the specimens used in this study.

The rather frequent persistence of the old thyroglossal duct extending as far as the hyoid bone and found in man in 27 percent

of the cases (Gudernatsch, '42), was not seen in any of these dogs. When one remembers the unpaired anlagen of the thyroid, it seems that the human thyroid and these five anomalies are more primitive than the type usually found in the dog. May we then call this an atavistic anomaly?

Absence of an Organ

There are three cases of this type. In one male fetus weighing 13.6 grams there was no urinary bladder. Both ureters ended in a mass of areolar tissue in the pelvis. The other two cases have one of the paired gonads missing. A male fetus of 18.140 grams of body weight had no left testis and a female of 20.6 grams of body weight had no right ovary. In both of these cases, the organ of the other side seemed to be perfectly normal in size, shape and location.

Anomalous Spleens

The last two anomalies are found in the spleen. The spleen in the dog is an elongated and flattened organ, and very small in the early fetus. One of these in a 97.5 gram male fetus had the dorsal end bifurcated. The entire spleen was small, weighing but 0.1972 gram. The notch causing this bifurcated tip was not more than 3 mm. deep. In another male with a body weight of 56.0 grams, there was a small accessory spleen. This spherical mass of splenic tissue was about 2 mm. in diameter and located in the greater omentum.

All of these anomalies, with the exception of the first, have been reported before but it seems worth-while to present these to give some idea of the types of variations found in a series of fetal and newborn dogs and the frequency of their occurrence. Had these fetuses been permitted to go on to normal birth, most of these anomalies would not have prevented a normal adult life. The location of the spleen in the thoracic cavity might not have made any difference in the normal life of this dog. The piece of the small intestine herniated out through the umbilicus might have been retracted before birth, but the hernia through the muscular lacuna would probably have been a serious thing for this newborn puppy. Obviously the shape of the thyroid would have made no difference in the postnatal life of these dogs, provided it secreted a normal amount of thyroxine. The absence of one of the paired gonads would have made no difference, for very likely the one persisting gland would have hypertrophied and adequately cared for the need of the animal. The absence of the urinary bladder would be a very serious anomaly, had it not developed later before the birth of the dog.

This absence of the urinary bladder and the hernia through the muscular lacuna are probably the only cases which would have seriously affected the postnatal life of these puppies. Thus, in only two out of 176 fetuses and newborn puppies, or in only 1.1 percent of this series, were there any anomalies which would in any way have interfered with a normal postnatal life.

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The Bees of the Genus Proteriades (Hymenoptera, Megachilidae)

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ABSTRACT: This paper is a revision of a genus of bees, *Proteriades,* which is known only from California and adjacent states. It is remarkable for having peculiarly modified mouth parts which are used in obtaining pollen from the flowers of *Cryptantha.* So far as known bees of this genus collect pollen from no other plant. *Proteriades* is believed to have been derived from an *Anthocopa*-like ancestor.

The forms which have received the generic or subgeneric names *Cephalapis* and *Xerosmia* are here included in *Proteriades.* A total of twenty-two species are recognized, fourteen of which are described as new. In addition, three new subspecific names are proposed.

Proteriades is a genus of small megachilid bees, allied to *Hoplitis* and *Anthocopa,* and remarkable for having rather numerous species in spite of its limited distribution and for having specialized pollen collecting apparatus enabling its members to obtain pollen from flowers of *Cryptantha,* upon which it seems to be entirely dependent.

DISTRIBUTION

All the known species of the genus except *P. incanescens* (Cockerell) have been found only in California and occur from near sea level to 9,500 feet altitude in the mountains. *P. incanescens* ranges from eastern California into Nevada and Arizona. Presumably other species will also be found to occur in these states. This distributional pattern parallels that of certain other megachilid bees (see Michener, 1943, 1944a) which for some reason do not range nearly as far eastward and southward as does the desert habitat in which they occur in California.

Of the twenty-two species now recognized, fifteen are known in both sexes, with the sexes in most cases certainly allocated, but in a few cases a little uncertainly. Five species are known only in the female sex, and two only in the male sex. Several species are known to be widely distributed in California, while others remain known from only one or a few localities. One of us (Timberlake) has collected nine species, over one-third of the known species of the genus, on or in the immediate vicinity of the grounds of the Citrus Experiment Station in Riverside, California. This was done over a period of more than twenty years, and one species (*similis*) was found but once and another (*seminigra*) only during one year. Thus any locality where suitable conditions exist may continue to yield additional species for many years. We may have a good proportion of the species, but there certainly must be others still unseen. It is evident that much more material needs to be collected, and that many years may elapse before a full understanding of the genus is achieved.

POLLEN COLLECTING

It seems unquestionably true that all species of *Proteriades* collect pollen exclusively from flowers of the boraginaceous genus *Cryptantha*. The mouth parts (galeae and labial palpi) are provided with stiff curled hairs, especially in the female. These serve to pull the pollen from the stamens which are hidden in the throats of the flowers. These flowers are too small to permit the bees to enter bodily and collect pollen in the usual way. From the curled or hooked hairs of the mouth parts the pollen is transferred for carrying to the hairs of the scopa on the under side of the abdomen.

Thus far there is no evidence whatever to suggest that the different species of *Proteriades* are restricted to different species of *Cryptantha*. Several species of *Proteriades* have been collected on more than one species of *Cryptantha*, and the indications are that a species of *Proteriades* will utilize whatever *Cryptantha* species are available in the neighborhood. All eight species of *Proteriades* found at Riverside were on *Cryptantha intermedia*.

There is no evident relationship between speciation in *Cryptantha* and that in *Proteriades*. Not only are the *Proteriades* species not restricted to particular species of *Cryptantha*, but the distribution of the plant is far wider than that of the bee, extending eastward to the Great Plains and southward far into Mexico and even to South America. In this connection it should be pointed out that in the vicinity of Riverside, where eight species of *Proteriades* are com-

peting with one another, visiting the same flowers at the same season in the same place, the season of flight of the bees does not even coincide with the main bloom of the *Cryptantha* plants. These plants appear in great numbers, especially in bare and disturbed soils, and are at the height of their bloom in March. Many of them may dry up before the end of that month. Other plants, more favorably situated, as on a north slope or at the edge of a boulder or wherever the soil retains its moisture longer than in exposed places, may bloom through April and May into June. It is mainly such plants which support the *Proteriades* populations.

However, at high altitudes in the Inyo Mountains the *Proteriades* are on the wing a few days before the first *Cryptantha* flowers are in bloom. Here the situation is wholly different from that in coastal southern California (Riverside) for in these high desert ranges the season is extremely short and probably no *Cryptantha* plant survives the aridity to bloom for more than a few weeks.

While collecting pollen at flowers the females are easy to collect, in comparison with the males, and it is partly on account of this that as many as five species are known only from the female sex, The females also undoubtedly have a much longer season of flight. The males, on the other hand, have the habit of sunning themselves on the ground, or on a convenient stone or stick, from which they make periodic sorties over the *Cryptantha* flowers apparently in search of mates, only occasionally lingering at the flowers to feed.

The nesting habits of only *P. xerophila* (Cockerell) have been observed, but presumably all the species nest in the ground. As reported by Michener (1943), *P. xerophila* was reared from old nests of *Anthophora linsleyi* Timberlake which were dug from the ground by Doctor G. E. Bohart.

Phylogeny

From our meager knowledge it is impossible to draw a reliable phylogenetic tree of *Proteriades,* but it is possible to suggest the relationships of certain species. The genus apparently evolved from an *Anthocopa*-like ancestor, as it agrees with that genus in the robust form, in the clypeus usually produced well over the base of the labrum, and in having the inner surface of the hind coxae flattened and carinate along the inner ventral margin. The departure from an *Anthocopa*-like structure is in having specialized, stiff, hooked hairs in the mouth parts and in having the base of the first metasomal tergum much less basinlike and more sulcate medially as in the genus *Hoplitis* although to a less degree.

As the bulk of the species of *Anthocopa* and *Hoplitis,* as well as of other related genera such as *Osmia,* have five-segmented maxillary palpi, it is clear that this is a primitive characteristic. It is retained in only two species of *Proteriades, remotula* and *incanescens.* These species, although specialized in certain respects, appear to constitute the most primitive group of *Proteriades,* which we will call the *remotula* group. It is perhaps significant that the group is relatively widespread, occurring from northernmost California to the southern part of the state and eastward at least to Southern Nevada and the Grand Canyon region of Arizona. The male of *remotula* is remarkable in having very few hooked hairs on the mouth parts, and these but little hooked. This may be another primitive characteristic. Unfortunately the male of *incanescens* is unknown.

No doubt derived from the *remotula* group is a large group, the bulk of the genus, which may be called the *tristis* group. It differs from the *remotula* group principally in having four or less segments in the maxillary palpi. The species included are *basingeri, bidenticauda, caudex, cryptanthae, hamulicornis, nanula, nigra, palmarum, pygmaea, reducta, seminigra, similis, tristis, truicauda,* and *xerophila.* Specialization along several different lines is evident in this group. For example, reduction in the maxillary palpi to two segments occurs in *reducta,* reduction in size in *nanula* and *pygmaea.* The males of several species show special modifications; for example, the acute antennae of *hamulicornis,* the ventral protuberance of the base of the abdomen of *caudex* and *cryptanthae,* the long scoop-shaped apical tergum of *truicauda,* and the bidentate apical tergum of *bidenticauda.* The last structure is similar to that of *deserticola,* a member of the *semirubra* group, but there seems to be no close relationship between *bidenticauda* and *deserticola,* the bidentate tergum having arisen independently in the two groups.

P. xerophila differs from other members of the *tristis* group principally by its large size and the tridentate seventh metasomal tergum of the male. The sixth sternum has a pair of lobes, one on each side of the short median fold. As these differences are no more striking than the differences between certain members of the *tristis* group, *xerophila* is included in that group. It is the type species of *Xerosmia,* a name which might well be used in a subgeneric sense for all members of the *remotula* and *tristis* groups.

The *semirugra* group is characterized by very distinctive females but has males scarcely distinguishable from those of the *tristis*

group. It is no doubt derived from the *tristis* group. In the females the mandibles are thick, not gradually narrowed subbasally as in the *remotula* and *tristis* groups. The clypeus of the female is thickened, either short and but little overhanging the labrum or produced into a pair of fingerlike projections. In the male the second metasomal sternum has a broad transverse subapical ridge which extends uniformly across the segment. In members of the *tristis* and *remotula* groups this ridge, if present at all, is interrupted medially. Species included in the *semirubra* group are *evansi, deserticola,* and *semirubra. P. boharti* is tentatively included although unknown in the female. In the event of a subgeneric division of *Proteriades,* this group would be called *Proteriades* s. str.

The last group contains the single species *jacintana,* which is remarkable for its elongate form, broad genal areas, keeled clypeus in both sexes, the long nearly straight margin between the second and third mandibular teeth of the female, etc. This species may be placed under the subgeneric name *Cephalapis,* but as it is merely one more, highly specialized derivitive of the *tristis* group, the use of the subgeneric name seems unnecessary, unless *Xerosmia* is also utilized in a subgeneric sense for the *tristis* and *remotula* groups.

Systematic Treatment

The genus *Proteriades* was established by Titus (1904) for the male of a California bee described by Cockerell (1898) as *Heriades semirubra.* Other species that belong here are *Chelostoma* (*Cephalapis*) *jacintanum* Cockerell (1910), *Osmia remotula* Cockerell (1910), *Hoplitina incanescens* Cockerell (1922), *Osmia xerophila* and *O. palmarum* Cockerell (1935), and *Proteriades evansi* and *P. tristis* Michener (1936). *Cephalapis* Cockerell, which was described as a subgenus of *Chelostoma,* was based on a very distinctive species of *Proteriades* and possibly deserves recognition as a subgenus in its new position. In 1943 Michener erected the group *Xerosmia* for *Osmia xerophila* Cockerell and placed it as a subgenus in the genus *Anthocopa.* After reconsideration in the light of the numerous additional species of *Proteriades* now known, *Xerosmia* is removed to *Proteriades,* with which it agrees in every way except for certain specialized male characters. At that time it was believed (Michener 1941, 1943, 1944) that *Proteriades* was more closely related to *Hoplitis* than to *Anthocopa,* and it was the *Anthocopa*-like characteristics of *xerophila* that lead to its inclusion in *Anthocopa* as a subgenus. It is now apparent that other *Proteriades* share these characteristics, and *xerophila* must be placed with *Proteriades,*

which, however, could logically be regarded as a subgenus of *Anthocopa*.

The following is the synonymy of *Proteriades*:

Proteriades Titus

Proteriades Titus, 1904, Jour. New York Ent. Soc., 12: 25; Cockerell, 1906, Bull. Amer. Mus. Nat. Hist., 22: 445; Michener, 1936, Amer. Mus. Novitates, 875: 28; Sandhouse, 1939, Mem. Ent. Soc. Washington, 1: 2; Michener, 1941, Amer. Midland Nat., 26: 160; Sandhouse, 1943, Proc. U. S. Nat. Mus., 92: 591; Michener, 1944, Amer. Nat., 78: 262; Michener, 1944, Bull. Amer. Mus. Nat. Hist., 82: 263.

Type: *Heriades semiruba* Cockerell (monobasic).

Cephalapis Cockerell, 1910, Ann. Mag. Nat. Hist., (8)5: 23; Sandhouse, 1943, Proc. U. S. Nat. Mus., 92: 535.

Type: *Chelostoma* (*Cephalapis*) *jacintanum* Cockerell (monobasic and original designation),

Xerosmia Michener, 1943, Ann. Ent. Soc. Amer., 36: 81; Michener, 1944, Bull. Amer. Mus. Nat. Hist., 82: 264.

Type: *Osmia xerophila* Cockerell, by original designation.

As elsewhere explained, the genus can be recognized by the hooked or wavy hairs of the galeae and labial palpi. The first abdominal segment is intermediate in structure between that of *Anthocopa* and that of *Hoplitis*, being sulcate but more broadly so than usual in *Hoplitis*. Almost all of the species are small, black, with the abdomen partly red.

As indicated for each of the new species, holotypes are in the collections of the Citrus Experiment Station of the University of California, the California Academy of Sciences or in the Snow Entomological Collections of the University of Kansas. Paratypes of each species, wherever posible, are divided between these collections and where series of paratypes exist some have been sent to the American Museum of Natural History and the United States National Museum.

KEY TO THE SPECIES OF *Proteriades*

FEMALES

1. Clypeus with longitudinal median carinate ridge; mandible with apical tooth basad of which is a notch, followed by a long straight margin (fig. 7); genal area twice as broad as eye seen from side ..... *jacintana*

   Clypeus without longitudinal ridge and without carina except in *P. palmarum;* mandible tridentate (fig. 9); genal areas at most but little broader than eye... 2

2. Clypeus produced on each side (next to base of mandibles) as much as, or more than, in the middle, and not overhanging base of labrum or doing so only medially 3

   Clypeus distinctly more produced in middle than at the sides and overhanging base of labrum 4

3. Side of clypeal margin more produced than the middle, which is much elevated and perpendicularly declivous, the margin strongly arched as seen from beneath and leaving base of labrum fully exposed; mandibular teeth nearly equal... *evansi*

   Clypeal margin about equally produced at sides and in the middle, with a short median process that is moderately elevated over base of labrum; mandibles with inner apical tooth reduced to an angle and much shorter than the two acute outer teeth ..... *deserticola*

4. Clypeus truncate or rounded at apex; mandibles not broadened medially..... 5
Median lobe of clypeus strongly produced and with two fingerlike divergent processes between which is a small acute tooth; mandibles very broad at middle, deeply excavated on inner margin toward the base, and a little narrowed to apex ..... *semirubra*

5. Clypeal margin in middle more or less thin-edged and strongly projecting over base of labrum, not or feebly crenulate..... 6
Clypeal truncation thick-edged, crenulate with four or six small blunt teeth, and but little produced over base of labrum..... *cryptanthae*

6. Upper half or two-thirds of clypeus strongly swollen and shining and nearly impunctate medially; maxillary palpi five-segmented..... 7
Clypeus more uniformly convex with the punctures moderately dense to crowded (a median impunctate line in *palmarum*); maxillary palpi with two to four segments 8

7. Clypeal margin broadly rounded with no distinct angles demarking truncation; mesoscutum with punctures not coarser than those of vertex..... *remotula*
Clypeal margin with a clearly defined truncation; mesoscutum with punctures coarser than those of vertex..... *incanescens*

8. Abdomen black, or at most with a small amount of red on first tergum and sides of second; terga always with distinct white hair-bands; clypeal margin broadly truncate, or emarginate-truncate 9
Abdomen with much red on the three basal segments, the hair-bands well developed or not; clypeal margin usually less distinctly truncate, sometimes plainly rounded 12

9. Without red on abdomen (desert species)..... 10
Sides of first one or two segments of abdomen red (coastal and montane species), *tristis*

10. Smaller species, about 6 mm. long; distance between posterior ocelli subequal to distance from one of them to eye margin..... 11
Robust species, usually about 8 mm. long, rarely only 6.5 mm.; distance between posterior ocelli less than distance from one of them to eye margin..... *xerophila*

11. Clypeus strongly convex above the middle with longitudinal median raised impunctate line; emargination between second and third mandibular teeth arcuate ..... *palmarum*
Clypeus less strongly convex, without such a line or with it weakly developed; emargination between second and third mandibular teeth angular..... *nigra*

12. Clypeal margin broadly rounded, with a very obtuse sublateral angulation far to each side; small species about 3.0 to 4.6 mm. long..... 13
Clypeal margin more or less distinctly truncate in middle, that is with rounded angles demarking truncation in addition to sublateral angles; length about 5 mm. 15

13. Clypeus very densely punctured; prominences in front of ocelli shining and distinctly more sparsely punctate than vertex and rest of supraantennal area.. *similis*
Clypeus less densely punctured, with interspaces between punctures; prominences in front of ocelli not or scarcely more sparsely punctate than vertex and rest of supraantennal area..... 14

14. Small desert species, with pubescence white and unusually abundant on face, cheeks, sides of thorax and margins of mesoscutum; hair bands of abdomen broad and dense, the disk of last three terga covered with white hair; punctures of mesoscutum about a puncture-width apart; length usually not over 4 mm. ..... *pygmaea*
Slightly larger montane and coastal species with pubescence less clear white, less dense on face and thorax; disk of fourth tergum well exposed, that of fifth and sixth segments with sparse white hair; punctures of mesoscutum mostly less than a puncture width apart; length 3.5 to 4.5 mm..... *nanula*

15. Apical margin of clypeus not distinctly concavely arcuate on each side of the truncation 16
Apical margin of clypeus rather distinctly but shallowly emarginate on each side of the rather narrow truncation, the sublateral angulation strong but obtuse. (Punctures of clypeus close, those of mesoscutum rather coarse and almost uniformly less than a puncture width apart)..... *caudex*

16. Superior part of supraantennal area (frons), especially the slightly prominent areas just in front of the lateral ocelli, having the punctures more or less separated.. 17
Supraantennal area uniformly and very closely punctured, the surface appearing more dullish 19
17. First three metasomal terga and generally most of the fourth, red; abdominal bands weak; somewhat smaller species, about 4.5 to 5.5 mm. long..... 18
Abdomen black, the sides of all terga red, but decreasingly so toward apex; apical margins of first five terga conspicuously pallid, and the first four each with a dense white hair-band. Length 5.5 to 6 mm. (Sublateral angulations of clypeal margin very obtuse, so that the margin appears rather broadly rounded.), *truicauda*
18. Maxillary palpi short, indistinctly two- or three-segmented; apical truncation of clypeus rather distinct and about equal to the oblique sides, which have the sublateral angulation very obtuse ..... *reducta*
Maxillary palpi four-segmented and usually distinctly longer than in *reducta;* clypeal margin usually distinctly although minutely notched (the notch bearing a seta) just inside the lateral angulations, so that the latter are produced to form small blunt teeth..... ..... *bidenticauda*
19. Clypeal truncation distinctly less in width than the oblique sides of the apical margin; punctures of clypeus at least a puncture-width apart; punctures of mesoscutum close, but rather more separated than those of frons; first three terga, and sometimes a large part of fourth, red..... *hamulicornis*
Clypeal truncation about equaling width of oblique sides of the apical margin; punctures of clypeus rather less than a puncture-width apart; punctures of mesoscutum about equaling those of frons in density; basal terga more or less black in middle, the first sometimes only narrowly so, the fourth either entirely black or red at sides..... *seminigra*

MALES

1. Mandible longer than front tibia, with subapical dorsal angle so that it is virtually tridentate; clypeus with longitudinal median carina; emargination between lobes of ninth tergum deeply U-shaped..... *jacintana*
Mandible shorter than front tibia, bidentate; clypeus without longitudinal carina; ninth tergum, if bilobed, with emargination between lobes broad and shallow (except in *remotula*)..... 2
2. Seventh metasomal tergum tridentate; sixth sternum with two small but strongly projecting lobes on either side of base of median fold..... *xerophila*
Seventh tergum truncate, bidentate or bilobed; fifth sternum without such lobes 3
3. Seventh metasomal tergum bidentate at apex, the teeth small, separated by at least four times the width of a tooth..... 4
Seventh tergum truncate at apex, or notched medially, the teeth or lobes in that case at least half as broad as the space between them..... 5
4. Teeth of seventh tergum separated by a crescentiform emargination; second sternum with a broad, subapical, transverse ridge; fifth sternum fringed; abdomen with broad white apical hair-bands..... *deserticola*
Teeth of seventh tergum separated by a quadrate emargination; second sternum with an oblique swelling on each side subapically; fifth sternum not fringed, its posterior margin broadly transparent, without hairs; abdomen without hair-bands ..... *bidenticauda*
5. Flagellum rounded at apex; posterior coxae not concave mesially, not spined..... 6
Apical segment of flagellum produced beneath at apex into a fine, sharp hook; posterior coxae concave mesially, with long sharp spine arising from inner side at apex ..... *hamulicornis*
6. First sternum with a large hornlike swelling at apex..... 7
First sternum with at most a low median protuberance at apex..... 8
7. Process of first sternum narrowing to transverse truncate, thin-edged apex, its posterior face flat and perpendicular; seventh tergum truncate at apex... *cryptanthae*
Process of first sternum thick, trunklike, ending bluntly, its posterior face convex; second to fifth sterna each with an apical fringe; seventh tergum strongly emarginate at apex, the two lobes a little less wide than the median emargination ..... *caudex*

8. Seventh tergum no longer than preceding one; second sternum without a protuberance on each side 9
Seventh tergum much lengthened, the apical portion convex above, concave beneath, broadly truncate at apex, its lateral margins nearly straight and unarmed; second sternum with a protuberance on each side subapically .... *truncauda*
9. Impunctate margin of clypeus broadly emarginate, with small median protuberance or tooth; angles demarking clypeal truncation acute ..... *semirubra*
Margin of clypeus emarginate or not but without median tooth, often crenulate; angles demarking clypeal truncation obtuse 10
10. Posterior coxae each with inner carina elevated to form a lamella which is abruptly terminated at its apex; flagellar segments longer than broad ..... *boharti*
Posterior coxal carinae normal; flagellar segments shorter, at least subapical ones broader than long or rarely as long as broad 11
11. First sternum nearly nude, or thinly and uniformly hairy 12
First sternum with a triangular medio-apical area densely covered with white hair, which also fringes the margin. (Length at least 5 mm.; middle coxae not toothed.) ..... *reducta*
12. Maxillary palpi five-segmented; seventh tergum with a deep almost semicircular emargination separating lobes which are about half as wide as emargination, *remotula*
Maxillary palpi three- or four-segmented; seventh tergum truncate or with shallow emargination separating lobes which are at least as wide as emargination 13
13. Larger species, 5 to 7 mm. long; middle coxae each with a ventral angle or tooth in front of base of trochanter;[1] lateral margins of seventh tergum strongly angulated; teeth of mandibles equal or subequal (except in *seminigra*) 14
Small species, about 3 to 4.5 mm. long; middle coxae not toothed; lateral margins of seventh tergum very obtusely and weakly angulated; outer tooth of mandibles much longer than inner tooth 16
14. First sternum with a definite shining medio-apical protuberance; abdomen almost wholly red, infuscated apically ..... *basingeri*
First sternum nearly evenly and weakly convex across the apex; abdomen with black dorsally on most or all of the terga 15
15. Seventh tergum with hardly a trace of a median notch; first three or more metasomal terga with red ..... *seminigra*
Seventh tergum definitely notched to form two rounded lobes; red confined to sides of first two metasomal terga ..... *tristis*
16. Carina of inner ventral angle of posterior coxa weak, absent distally where coxa is beveled; distance from posterior ocellus to extreme posterior margin of vertex little more than diameter of ocellus; genal areas little more than half as wide as eyes seen from side; pubescence dense and brilliantly white, obscuring sculpturing of face up nearly to level of ocelli ..... *pygmaea*
Carina of inner ventral angle of posterior coxa conspicuous and complete, coxa not beveled; distance from posterior ocellus to extreme posterior margin of vertex nearly twice diameter of ocellus; genal areas much more than half as wide as eyes seen from side; pubescence dull white, not obscuring facial sculpturing above level of antennal bases ..... *nanula*

Proteriades remotula (Cockerell) (new combination)

Osmia remotula Cockerell, 1910, Can. Ent., 42: 170.
Erythrosmia remotula, Bray, 1917, Pomona Jour. Ent. Zoöl., 9: 96.
Hoplitina remotula, Cockerell, 1922, Amer. Mus. Novitates, 40: 6.
Hoplitis remotula, Sandhouse, 1939, Mem. Ent. Soc. Washington, 1: 140.

This species is not common and only a few specimens are known. The female can easily be recognized by the bulging upper half of the clypeus and the depressed lower half, as well as by the broadly rounded margin. It differs from other species, except *incanescens*, by the five-segmented maxillary palpi. The male, here described

1. Seen from the side of the body this projection appears as a tooth. Actually the middle coxa is produced ventrally, mesad and basad of the base of the trochanter, to form a small transverse rounded lamella.

for the first time, differs from other species in the almost semicircular emargination of the seventh metasomal tergum.

Male: Black, including abdominal sterna; first to third metasomal terga and sides of fourth red; posterior margins of third to fifth terga broadly testaceous. Mandibles red subapically; distal ends of tarsal segments reddish; under surface of flagellum and parts of tegulae dark brown. Wings dusky hyaline, stigma and veins black. Head much broader than long; inner orbits distinctly converging below. Genal areas over two-thirds as broad as eyes seen from side. Distance between posterior ocelli subequal to distance from one of them to posterior margin of vertex and to eye margin. Clypeal margin broadly convexly rounded, slightly crenulate, angulate sublaterally, margin not thickened. Mandible with outer tooth acute, inner blunt and much shorter than outer. Maxillary palpi five-segmented; hairs of galeae and labial palpi sparse and scarcely hooked. Hypostomal carinae low. Antennae short, first and last flagellar segments markedly longer than broad, second to fifth broader than long, remaining segments about as long as broad. Middle coxae not toothed. Posterior coxae not lamellate; carinae very inconspicuous. Sixth metasomal tergum only feebly angulate at sides. Sides of seventh tergum feebly angulate, not emarginate; apex strongly bilobed, emargination between lobes semicircular, about twice as broad as apex of a lobe. First metasomal sternum flat, sparsely pubescent, with irregular fringe along posterior margin. Second sternum without swellings, its posterior margin weekly emarginate medially, fringe feeble. Third, fourth, and fifth sterna conspicuously fringed, the fringes conforming to the broadly concave sternal margins. Sixth sternum without the usual ferruginous fold, but with a feeble longitudinal median ridge ending in a small projection between the broad apical lobes of the sternum. Punctation of head and thorax fine, that of vertex coarser than that of mesoscutum, clypeal margin broadly impunctuate but not smooth and shining. Pubescence white, pale ochraceous on dorsum of head and thorax, largely covering face to well above antennal bases, rather long and abundant on thorax, not forming abdominal bands. Length, 5.2 mm.; fore wing, 4 mm.

Female: Black, first three metasomal terga ferruginous red, sometimes narrowly blackish at the middle. (In a Modoc County female, third tergum black, with a red patch on each side at the base and a black patch on middle of the base of first two terga.) Tegulae dusky red to black, mandibles more or less reddish on

apical half, but the flagellum dark. Wings dusky hyaline, the stigma and veins nearly black. Head as broad as thorax, the genal areas nearly as broad as eyes seen from side. Distance between posterior ocelli equal to distance from one of them to posterior edge of vertex, less than distance from one of them to eye margin. Eyes rather strongly converging below. Clypeus large, bulgingly convex at base, apical two fifths abruptly depressed and only slightly arched from side to side, this part strongly projecting over labrum and bases of mandibles, its margin rounded out, although sometimes a little truncate medially, this truncation shorter than distance from end of truncation to eye margin, margins laterad of truncation gently concave, entirely without sublateral angles. Maxillary palpi five-segmented. Mandibles moderately expanded at apices and a little constricted near the base, the two outer apical teeth acute, the middle tooth closer to outer tooth than to inner one, the latter subacute, short, separated from middle tooth by a rounded emargination. Head and thorax closely and finely punctured. Punctures of clypeus a little coarser than those elsewhere, close at sides of disk, but widely separated on middle of basal convex area and on the apical depression. Pubescence rather thin and long, mostly erect on head and thorax, and whitish except more or less tinged with ochraceous on vertex and mesonotum. Hair of mesoscutum very short and fine, with longer erect hairs interspersed, but these mostly shorter than the hair of face and scutellum. Abdomen with appressed hair, denser on the three apical segments, but not forming bands. Hair on sides of first tergum longer and erect. Length, 5.5 to 6.5 mm.; fore wing, 3.8 to 4.5 mm.

Type locality: Claremont, Los Angeles County, California. Other specimens are as follows: One female, La Crescenta, Los Angeles County, California, on *Cryptantha intermedia,* May 5, 1935 (P. H. Timberlake); one female, Newhall, Los Angeles County, California, April 20, 1940 (R. M. Bohart); two females, Riverside, California, on same flower, April 6, 1945 (P. H. Timberlake); one male, one female, Pinacles National Monument, San Benito County, California, April 24, 1948, on *Cryptantha* (P. D. Hurd); one female, Rock City, Mount Diablo, Contra Costa County, California, May 24, 1940 (E. G. Linsley); one female (unusually dark in coloration), Fandango Pass, Modoc County, California, July 10, 1946, on *Asclepias* (P. D. Hurd, R. F. Smith) from the collection of Doctor U. Lanham.

The type is in the United States National Museum.

We are indebted to Dr. E. G. Linsley and Mr. P. D. Hurd of the University of California for the opportunity to study the male of this species.

Proteriades incanescens (Cockerell) new combination

This is a medium sized or large species, the female (male unknown) of which has the upper portion of the clypeus strongly convex, shining, with punctures separated by more than their diameters. In this respect it resembles *remotula* and to some extent *hamulicornis*. Both of these species are smaller and neither has the strongly produced and clearly truncate clypeal margin which characterizes *incanescens*. Another distinctive feature of *incanescens* is the long antennal scape, which is almost five times as long as broad and longer than the distance between the inner margins of the antennal sockets. In other species the scape is usually less than four times as broad as long and scarcely longer than the distance between the inner margins of the antennae sockets.

Female: Black, first three metasomal terga and sometimes base of fourth red. Mandibles dark red, infuscated basally. Antennal flagellum brown, paler beneath. Legs brownish black, tarsi paler, distitarsi rather light brown. Tegulae brownish black. Wings clear, veins and stigma blackish. Head about as wide as thorax and about as long as broad. Genal areas as wide as eye seen from side. Distance between posterior ocelli subequal to distance from one of them to eye margin and to posterior edge of vertex. Inner orbits converging below. Upper two thirds of clypeus strongly convex, lower third depressed, margin strongly produced over labrum to a broad truncation which is feebly emarginate medially, angles demarking truncation conspicuous, separated by distance equal to distance from one of them to lateral angle of clypeus, sublateral angles of clypeus virtually absent. Mandibles narrowed near the base by a gentle emargination of the inner margin as usual in this group; apices with distance between outer and middle teeth less than that between middle and inner teeth, all teeth acute. Hypostomal carinae highest behind angle, gradually narrowed anteriorly. Maxillary palpi five-segmented. Punctation rather coarse and sparser than in many species, convex upper portion of clypeus coarsely punctured, median portion shining with punctures separated by several diameters but laterally puctures are closer; mesoscutum at least as coarsely and less closely punctate than vertex and at least as coarsely punctate as mesepisternum, areas mesad to parapsidal

furrows sometimes a little more finely and closely punctured than adjacent areas. Pubescence abundant and white except for vertex and disk of mesoscutum where it is pale ochraceous; supraclypeal and paraocular areas densely pubescent nearly to level of anterior ocellus; thorax rather more densely pubescent than usual; first three metasomal terga with narrow apical bands of pubescence which are broken medially; fourth more densely pubescent but with a denser apical band; fifth and sixth uniformly covered with white pubescence. Scopa yellowish white.

Proteriades incanescens incanescens (Cockerell) new combination

Hoplitina incanescens Cockerell, 1922, Amer. Mus. Novitates, 40: 7.

This subspecies differs from the following by its larger size, the presence of red on the base of the fourth metasomal tergum, and perhaps by the slightly coarser punctation of the mesoscutum. Length, 7.0 to 7.5 mm.; fore wing, 4.8 mm.

This subspecies is known from two specimens, the type from Grand Canyon, Arizona, May 24, 1918, and another from the same locality (7,000 feet altitude), June 5, 1940 (R. M. Bohart). The type is in the collection of the American Museum of Natural History and was lent for study through the courtesy of Dr. Mont A. Cazier.

Proteriades incanescens nevadensis new subspecies

This subspecies differs from the above in its smaller size, the absence of red on the base of the fourth metasomal tergum, and the slightly finer mesoscutal punctation. Length, 6.0 to 6.5 mm.; fore wing, 4.0 to 4.2 mm.

Holotype female: Kyle Canyon, Charleston Mountains, Nevada, May 24, 1940 (G. E. Bohart). One female paratype: Owens Valley, Mono County, California, 7,000 feet altitude, May 31, 1941, (R. M. Bohart).

The holotype is in the collection of the California Academy of Sciences, San Francisco, California.

A specimen from Deep Creek, San Bernardino County, California, May 9, 1936 (E. G. Linsley) has the clypeus less clearly truncate than in *incanescens*, and has the interocular and interocellar distances more as in *remotula*. It probably represents either a new species or, more likely, an intergrade between *nevadensis* and *remotula*. If the latter interpretation is correct, *incanescens* and *nevadensis* should both be considered subspecies of *remotula*.

Proteriades tristis Michener

Proteriades tristis Michener, 1936, Bull. Southern Calif. Acad. Sci., 35: 92.

This is a rather large species, black with the red confined to the first two abdominal segments. It thus resembles the structurally very different *P. jacintana*.

Male: Black, large lateral areas on the first metasomal tergum, nearly meeting dorsally, and small areas at sides of second tergum red. (One specimen has red areas at sides of third tergum.) Posterior margins of first six terga broadly testaceous. Flagellum and parts of tarsi dark brown. Mandibles red subapically. Tegulae amber colored. Wings dusky, veins and stigma black. Head as wide as thorax. Genal areas nearly as wide as eyes seen from side. Distance between posterior ocelli less than distance from one of them to posterior margin of vertex or to eye margin. Inner orbits slightly converging below, except for lower portions which are slightly divergent. Flagellar segments mostly slightly longer than broad but first very short and broader than long. Clypeal truncation broader than labrum, delimited by distinct angles, slightly concave, sometimes slightly crenulate; margin of truncation distinctly and broadly thickened. Mandibles with outer tooth not greatly longer than inner. Maxillary palpi four-segmented. Middle coxae each with distinct tooth in front of base of trochanter. Posterior coxae not lamellate, although carinae are very high. Sixth tergum with a distinct small tooth at each side. Seventh with a conspicuous emargination on each side separating the rounded lateral teeth from the bilobed median projection. First metasomal sternum but little thickened, without protuberance. Second to fifth sterna fringed, fringe of second short and rather irregular, of third long and conforming to emargination of sternum, of fourth shorter and rather sparse, of fifth still shorter but dense. Sixth sternum with the usual ferruginous fold, the summit of which is flattened and provided with short pubescence; apex of fold produced into a spine. Punctation rather fine, finer and closer on clypeus and lower parts of paraocular areas than elsewhere on head, markedly coarser on mesepisterna than elsewhere on head and thorax. Punctation of abdomen relatively coarse, many of punctures larger than those of mesoscutum. Pubescence white, rather sparse, not completely hiding surface even on clypeus, forming weak apical bands on lateral portions of metasomal terga. Length, 5.6 to 7.0 mm.; fore wing, 4.0 to 4.8 mm.

Female: Coloration similar to male, red of second tergum often greatly reduced or even absent. Head as wide as thorax, broader

than long. Genal areas as wide as eye seen from side. Distance between posterior ocelli slightly less than distance from one of them to eye margin or to posterior margin of vertex. Eyes slightly converging below. Clypeus not strongly bulging, margin with distinct truncation broader than distance from end of truncation to lateral angle of clypeus; angles demarking ends of truncation distinct, sublateral angles weak and close to ends of truncation. Mandibles narrowed near base by emargination of inner margin; apex with teeth acute. Maxillary palpi four-segmented, rather long and slender. Punctation much as in male. Clypeus closely punctured, a little more coarsely so than rest of head. Pubescence rather sparse, white, faintly ochraceous on dorsum of head and thorax, forming apical bands of white pubescence on posterior margins of first four metasomal terga and covering surfaces of fifth and sixth terga. Scopa white. Length, 6.0 to 7.0 mm.; fore wing, 3.8 to 4.2 mm.

The holotype of this species, from Eagle Rock Hills, Los Angeles County, California, is on deposit in the California Academy of Sciences. Additional specimens are from La Crescenta, Los Angeles County, California; Altadena, Los Angeles County, California; Idyllwild, Ribbonwood, Vandevanter Flat, and Santa Rose Mountain (6,400 and 7,500 feet altitude), San Jacinto Mountains, California (all C. D. Michener); Mill Creek, San Bernardino Mountains, California (P. H. Timberlake). The species has been collected on *Cryptantha intermedia* and *C. micrantha*. Males have been collected on dates ranging from May 2 to June 18, females May 5 to June 19.

Proteriades seminigra new species

This is one of the smaller species of generalized structure. The male is similar to that of *tristis*, but smaller, with much more red on abdomen and the apex of the seventh metasomal tergum not bilobed. The female agrees with *hamulicornis* in having the punctures of the frons almost uniformly close, but differs in having less red on the abdomen and the punctures of mesoscutum about as close as those of the frons. The metasomal sterna are usually largely black, while in other species they are usually reddened.

Male: Black, the first four metasomal terga red on each side. First tergum red except for a median black line, the following segments increasingly broadly black in middle, the fourth with about the middle half black. Apical margins of terga, except the last, and especially of the third to sixth, broadly rufotestaceous. Venter

black. Mandibles red between middle and bases of teeth (or nearly all red). Flagellum a little reddened beneath. Tarsal claws ferruginous. Tegulae amber color. Wings dusky hyaline, the stigma and veins nearly black. Head slightly broader than long, and broader than thorax. Genal areas nearly as wide as eyes seen from side, widest opposite middle of eyes, and narrowing above. Antennae moderately long, with middle segments of flagellum nearly as long as wide. Margin of clypeus with a broad, somewhat crenulate and slightly concave truncation, the margin of which is thickened and impunctate, this truncation broader than labrum and limited by distinct angles. Mandibles with outer tooth much longer and slender than inner tooth. Maxillary palpi short and plainly four-segmented. Middle coxae each with a small ventral tooth in front of base of trochanter; hind coxae not lamellate. Sixth metasomal tergum obtusely toothed far to each side, the tergal margin basad of this tooth conspicuously convex. Seventh tergum strongly and broadly notched on lateral margins to produce obtuse lateral angulations and the moderately broad apical process, the latter well rounded on apical corners and only feebly emarginate medially. First sternum evenly convex across apex, where it is only slightly elevated above the following segment; pubescence sparse and evenly distributed except for being somewhat denser along posterior margin. Second sternum without definite preapical swelling. Apical fringes on second to fifth sterna long, becoming very dense in middle of third sternum and conforming to broadly emarginate apical margin of fifth sternum. Ferruginous median fold on sixth sternum well developed, flattened on summit, especially basally and provided with short pubescence, apex produced as a short spine. Head and thorax finely and closely punctured, the punctures dense on clypeus, and very close on frons and mesocutum. Abdomen minutely and closely punctured, the punctures becoming sparser on middle of discs of first and second terga. Pubescence white, forming the usual dense brush on clypeus, and long and rather dense on cheeks, sides of thorax and around margins of mesonotum. Hair of abdomen short, fine, and appressed, becoming denser on apical segments, and longer and erect along the lateral margins. Length, 4.5 mm.; fore wing, 3.5 mm.

Female: Black, with red on sides of first three metasomal terga. Mandibles red except at base on outer side. Head as broad as long, the genal areas over three fourths as broad as eyes seen from side. Posterior ocelli a little closer to edge of vertex than to the eyes, the

distance between them about equal to distance to vertical margin. Antennae short and slender, the segments of flagellum, except apical one, no longer than broad. Mandibles not much broadened to apex, and constricted as usual before the base, the three teeth rather short and subequal, all acute. Disk of clypeus gently convex at base, apical third depressed. The apical margin of clypeus with truncation feebly concave medially and slightly reflexed, a little longer than the oblique sides, angles demarking truncation distinct, margins about half-way between ends of truncation and margins of eyes. Punctures of head and thorax of about the usual size but more uniformly close than usual. Punctures of clypeus much less than a puncture width apart, a narrow impunctate strip bordering the apical truncation. Punctures of frons, vertex and mesonotum almost uniformly less than a puncture width apart, those of mesopleura more separated. Abdomen very finely and closely punctured. Pubescence white, moderately dense on face and sides of thorax. Vertex and disk of mesoscutum comparatively nude, but provided with a fine appressed pubescence interspersed with somewhat longer erect hairs. Abdomen with sparse, very fine, short, appressed hair and narrow apical bands formed of whiter, more pumose hair on the first three terga, the discal hair becoming progressively denser on the last three segments but not forming bands. Ventral scopa short and whitish. Length, 5 mm.; fore wing, 3.8 mm.

Type material: See *seminigra seminigra.*

Proteriades seminigra seminigra new subspecies

This form differs from the following in having the inner orbits of the eyes of the male slightly converging below and the distance between the posterior ocelli of the male subequal to the distance from one of them to the eye margin or the posterior margin of the vertex. There is slightly more black on the dorsum of the abdomen in both sexes than in *yosemitensis,* the red on the second metasomal tergum of the female occupying about the outer third on each side, with slightly more red on first tergum and less on third.

Holotype male: Riverside, California, on *Cryptantha intermedia,* April 15, 1938 (P. H. Timberlake). Allotype female, May 6, 1938, and one male paratype April 21, 1938, with data otherwise the same. One female paratype, La Crescenta, Los Angeles County, California, on *Cryptantha intermedia,* April 19, 1936 (C. D. Michener). The holotype and allotype are in the collection of the Citrus Experiment Station.

Proteriades seminigra yosemitensis new subspecies

This form differs from typical *seminigra* in having the head of the male broader, the inner orbits of the eyes of the male with upper portions slightly converging below but lower portions slightly diverging below. The distance between the posterior ocelli of the male is less than the distance from one of them to the nearest eye margin or the posterior margin of the vertex. There is less black on the abdomen in both sexes so that the first metasomal tergum may be almost wholly red above in either sex and the second tergum of the female often has only a small middorsal black area.

Holotype male, allotype female, and four male and six female paratypes: Yosemite, California, 3,880-4,000 feet altitude, May 25 and 31, 1938, some on *Cryptantha* (R. M. Bohart). An additional male, not a paratype, from Palmdale, California, April 11, 1936 (G. E. and R. M. Bohart). The holotype and allotype are in the collection of the California Academy of Sciences, San Francisco, California.

Three specimens from Big Pine Creek, Inyo County, California, 7,500 feet altitude, June 12 to 17, 1942 (R. M. Bohart) are tentatively assigned to this subspecies although the single male has the distance between the posterior ocelli as in typical *seminigra*.

Proteriades palmarum (Cockerell) new combination

Osmia palmarum Cockerell, 1935, Pan-Pacific Ent., 11: 48 (part).
Anthocopa (Xerosmia?) palmarum, Michener, 1943, Ann. Ent. Soc. Amer., 36: 83.

This is one of two small species of *Proteriades* without red on the abdomen; it differs from the other, *P. nigra*, by the presence of an impunctate line on the clypeus. It does not seem probable that its male will prove to have the peculiar characters of *P. xerophila* (Cockerell).

Female: Black, with no red on abdomen, except a reddish stain for a short distance between the black disks and testaceous apical margins of the first five metasomal terga. Mandibles red in apical third or half, and flagellum more or less reddened beneath. Tegulae clear amber color. Wings a little dusky hyaline, the stigma and nervures brownish. Head broader than thorax, but no broader than long. Genal areas as wide as eyes seen from side, widest at and below the middle of eyes and narrowing above. Posterior ocelli about the same distance apart as distance to eye margin and slightly farther apart than distance to edge of vertex. Maxillary palpi short, with four nearly equal segments. Mandibles moderately expanded at apices and strongly constricted before bases by an emargination

of the inner margin of each. Three apical teeth of mandibles decreasing in size and acuteness from the outer to inner tooth, the two inner teeth being separated by a rather shallow emargination, inner tooth scarcely acute. Clypeus large, with the strongly produced, thin-edged anterior margin broadly truncate, truncation demarked by broadly rounded angles. Disk of clypeus gently convex, rather narrowly depressed apically. Head and thorax closely and finely punctured, the punctures of frons and mesoscutum mostly less than a puncture width apart. Punctures of clypeus of about the same closeness, but leaving a narrow smooth raised median line and a transverse punctureless strip across the border of the truncation. Abdomen with minute close punctures. Pubescence rather abundant and white, except that it is slightly tinged with ochraceous on the vertex and disk of mesoscutum. Hair-bands of first four metasomal terga broad, dense and white, widening at sides of first tergum. Disks of following terga covered with appressed whitish hair. Ventral scopa short and white. Length, about 5.5 mm.; fore wing, 4 mm.

The holotype, from Palm Springs, Riverside County, California, at flowers of *Cryptantha,* March 24, 1933, is in the collection of the Citrus Experiment Station at Riverside, California. Another specimen from the same locality, on *Cryptantha barbigera,* was collected on March 30, 1945 (P. H. Timberlake). A third specimen is from nineteen miles west of Kane Springs, California, on *Cryptantha angustifolia,* March 25, 1933 (P. H. Timberlake).

Proteriades nigra new species

Osmia palmarum Cockerell, 1935, Pan-Pacific Ent., 11: 48 (part).

This species is similar to *palmarum,* from which it differs in having the clypeus more uniformly convex and more closely puctured almost all over, and in the mandibular dentition and greater width of the frons.

Female: Black, the mandibles at apex and flagellum beneath dark red. Apical segment of each tarsus and the claws dark ferruginous. Abdomen without red except in a narrow erythrized area between the whitish apical depression and the black disk of the first five metasomal terga. Tegulae pale amber color. Wings faintly dusky, the stigma and nervures dark brown. Head a little broader than thorax, the facial quadrangle distinctly broader than it is in *palmarum.* Genal areas about three fourths as wide as eyes, narrowed above. Posterior ocelli about as far apart as the distance from each eye and slightly farther apart than distance to edge of vertex. Inner

orbits of eyes nearly parallel. Clypeus evenly convex on basal part and slightly and broadly depressed across the apex; apical margin with truncation about equal to oblique sides, which are slightly angulated (by the sublateral angles) rather close to the ends of truncation; truncation limited by distinct angles which are much less rounded than in *palmarum*. Mandibles moderately expanded at apices and strongly constricted before bases by an emargination of upper margin of each; outer and middle teeth short and rounded (perhaps worn in type), the innermost (which is only slightly acute) separated from middle tooth by a rectangular emargination. Maxillary palpi consisting of four subequal segments; hypostomal carinae moderately high behind angles, gradually reduced at and in front of angles. Head and thorax finely and closely punctured, the punctures becoming distinctly sparser but no coarser on mesepisterna. Punctures of clypeus partly longitudinally lengthened and confluent, so as to appear slightly sulcate and almost uniformly close, except for a narrow apical punctureless strip across the truncation (and an ill-defined median impunctate line in paratype). Abdomen closely and minutely punctured, the punctures becoming dense on the sides of the terga. Pubescence white and moderately dense on head and thorax, with the vertex and disk of mesoscutum well exposed. First four metasomal terga each with a dense white apical hair band, that on first much broadened on each side. Fifth and sixth terga uniformly covered with appressed white hair. Ventral scopa short and whitish. Length, 5.8 mm.; fore wing, 4 mm.

Holotype female: Four miles east of Edom (now called Thousand Palms), Riverside County, California, on *Cryptantha angustifolia,* April 17, 1937 (P. H. Timberlake). One female paratype (a co-type of *palmarum* in the Museum of the University of Colorado), Palm Springs, Riverside County, California, on *Cryptantha angustifolia,* April 2, 1927 (P. H. Timberlake). Another female paratype, eighteen miles east of Desert Center, Riverside County, California, on *Cryptantha barbigera,* April 13, 1949 (P. H. Timberlake). The holotype is in the collection of the Citrus Experiment Station, Riverside, California.

Proteriades similis new species

This species differs in the female from any of the other smaller species, except *bidenticauda,* in having the punctures of the clypeus dense enough to dull the surface. It differs from *bidenticauda* in having the punctures of clypeus more round, the clypeal margin a little notched on each side, the antennae shorter, and the punctures

of the frons finer and denser. Superficially it resembles a large specimen of *nanula,* from which it differs in the clypeal punctation, among other characters. This species may be the female of *basingeri.*

Female: Black, with first three metasomal terga and sides of the fourth rather dark ferruginous red, but base of first tergum, a small spot at base of second, and middle of the third, black. Mandibles black on basal half and at apex, and red preapically. Antennae entirely dark. Tarsi slightly brownish. Tegulae amber color. Wings dusky hyaline, the stigma and nervures dark brown, with subcosta nearly black. Head about as broad as long, and broader than thorax. Inner orbits of eyes slightly converging below. Distance between posterior ocelli subequal to distance from one of them to eye margin, slightly more than distance to posterior edge of vertex. Mandibles moderately broad at apices, the teeth acute and decreasing in size from outermost to innermost. Maxillary palpi short but distinctly four-segmented. Hypostomal carinae moderately high posteriorly, gradually reduced toward angles and much reduced in front of angles. Antennae short, the segments of flagellum, except the last, no longer than thick. Disk of clypeus gently convex basally, and depressed on apical fourth. Margin of clypeus broadly rounded out medially, rather strongly but obtusely angulate by the sublateral angles on each side, and minutely emarginate on each side, just within the sublateral angulation, that is, between the sublateral angles and the angles demarking the truncation proper, the latter very feeble and recognizable largely because the slightly thickened and shining margin of the truncation proper ends at these angles. Head and thorax closely and rather finely punctured. Punctures of clypeus and supraclypeal area dense, imparting a dull effect, those of frons becoming a little separated on the convexities in front of the posterior ocelli. Punctures of mesoscutum mostly less than a puncture-width apart, but becoming more widely spaced just mesad of the parapsidal lines. Punctures of mesepisterna two to three puncture-widths apart, except on anterior margin where they are close. Abdomen minutely and closely punctured, the punctures finer and sparser on middle of disk of first tergum. Pubescence white and moderately dense on face and sides of thorax, and sparse, short and pale ochraceous on vertex and mesonotum. Hair of abdomen whitish and thin, a little denser on apical segments, and forming very narrow, thin, apical bands only on each side of first three metasomal terga. Ventral scopa short and whitish. Length, 4.6 mm.; fore wing, 3 mm.

Holotype female: Riverside, California, on *Cryptantha intermedia,* April 7, 1938 (P. H. Timberlake), in the collection of the Citrus Experiment Station, Riverside, California.

Proteriades nanula new species

This is distinguishable from other species, except *pygmaea,* by its small size and by having the margin of clypeus of the female more completely rounded out. The almost equally small *P. similis* differs by having the clypeus very densely and finely punctured. The males of *nanula* and *pygmaea* have the lateral margins of the seventh tergite feebly angulated, with only a slight emargination before the apical truncation. *P. nanula* differs from *pygmaea* by being larger and less hairy and by having the wings duskier. Certain other differences are indicated in the key.

Male: Black, with the abdomen, including venter, ferruginous (sometimes almost entirely so), basal middle of the terga more or less blackened, generally most extensively so on fourth and fifth terga. Mandibles with a red subapical band (or almost entirely rufous). Labrum dark testaceous. Flagellum and tarsi more or less brownish. Tegulae dark amber color. Wings dusky hyaline, the stigma and veins dark brown. Head as broad as long, the inner orbits converging below a little more distinctly than in most other species. Genal areas more than half as wide as eyes seen from side. Clypeal truncation slightly broader than labrum, limited by distinct angles, its margin impunctate, not thickened, slightly crenulate. Mandibles with teeth acute, with the outer one considerably longer than the inner tooth. Maxillary palpi tapering, four-segmented (or sometimes with last two segments fused, thus three-segmented). Hypostomal carina low. Distance between posterior ocelli subequal to distance from either to eye margin and greater than distance to edge of vertex. Antennae short, the scape short and a little swollen, middle segments of flagellum broader than long. Middle coxae not toothed; posterior coxae not lamellate. Tooth on each side of sixth metasomal tergum short and obtuse. Sides of seventh tergum shallowly emarginate before the apex, so that the angulations are very low and obtuse. Apex moderately wide, bilobed because of a median indentation (or truncate because of absence of this indentation). First sternum sparsely pubescent, evenly convex across the apex, slightly elevated medially and rather abruptly declivous behind. Second sternum planate, without preapical swelling, its apical fringe poorly developed. Fringes on third to fifth sterna rather long and

dense, conforming to the curvature of margins. Sixth sternum with the usual ferruginous median fold. Puncturation of head and thorax fine and very close, that of mesopleura much sparser than elsewhere. Punctures of clypeus sparse apically, leaving a more or less evident narrow impunctate space across margin. Pubescence white, rather sparse, with frons, vertex, disc of mesoscutum and base of scutellum well exposed. Brush of hair on clypeus and face below antennae moderately dense. Hair of abdomen sparse, not forming bands. Length, 3.0 to 4.0 mm.; fore wing, 2.4 to 2.8 mm.

Female: Black, with the first three metasomal terga and sides of fourth and fifth ferruginous red, a blackish stain or spot, however, often more or less developed at middle of base of the basal segments. Mandibles clear red in apical half (or more), teeth black. Flagellum and tarsi slightly reddened. Inner orbits of eyes converging below. Mandibles constricted near the base and moderately wide at apex, the teeth all acute, nearly equally spaced, with the outermost one the largest. Distance between posterior ocelli subequal to distance to edge of vertex and to distance to eye margin. Clypeal margin rounded, angles limiting truncation virtually unrecognizable, sublateral angles distinct and midway between ends of truncation and lateral angles of clypeus. Head and thorax closely punctured, the punctures rather coarse in relation to the small size of the insect (the punctures almost as large as those of the much larger *P. semirubra*). Punctures of clypeus and mesopleura a little sparser than elsewhere. Punctures of abdomen nearly as strong and but slightly sparser than those of mesonotum, nearly uniform in distribution, except that they become considerably sparser and finer on middle of the first tergum. Pubescence moderately dense and whitish on face, cheeks, sides of thorax and around margins of mesonotum. First four terga each with a narrow white apical hair-band, which is seemingly easily worn or rubbed. Last two terga evenly covered with appressed whitish hair, partially concealing the surface. Length, 3.5 to nearly 5 mm.; fore wing, 2.3 to 3 mm.

Type material: See *P. nanula nanula.*

Proteriades nanula nanula new subspecies

This is a small subspecies with the wing length not exceeding 2.8 mm., with punctation rather coarse, with the red of the abdomen extensive so that the black areas of the first three metasomal terga of the female do not reach the posterior margins of the terga and occupy only one fourth or less of the width of the terga.

This subspecies occurs in the lowlands of Southern California.

Holotype male: Riverside, California, on *Cryptantha intermedia,* April 3, 1938 (P. H. Timberlake). Allotype female with the same data, but collected April 26, 1937. Seven male and nine female paratypes from the same locality and flower, males taken from March 12 to May 6, females from March 12 to May 9; two female paratypes, one and one half miles west of Perris, California, April 27 and May 4, 1938; two female paratypes, the Gavilan, California, April 16, 1939, and April 17, 1938; one female paratype, Claremont, California, May 4, 1945 (all collected by Timberlake).

The holotype and allotype are in the collection of the Citrus Experiment Station.

Proteriades nanula sparsa new subspecies

Somewhat larger than typical *nanula,* wing length of the female usually 3 mm., punctation finer than in *nanula,* black areas of abdomen more extensive, the black of the first three metasomal terga reaching back to the rufous margins of the terga and on the third tergum occupying almost the dorsal third of the tergum.

This subspecies ranges across central California from near the coast to the east side of the Sierra Nevada, and, to judge by a single specimen, ranges into southern California in the mountains.

Holotype male, allotype female, and two female paratypes: Hastings Natural History Reservation, near Jamesburg, Santa Lucia Mountains, Monterey County, California, 1,900-2,700 feet altitude, on *Cryptantha,* June 6, 1938 (C. D. Michener). One male paratype, some data, but June 4, 1938; two female paratypes, near Coalinga, California, June 8, 1941 (R. M. Bohart); one female paratype, Yosemite, California, 3,880 to 4,000 feet altitude, May 25, 1938 (D. W. Hendrickson); three male and one female paratypes, same locality, May 25 and 31, 1938, on *Cryptantha* (R. M. Bohart); one female paratype, Badger, Tulare County, California, on *Cryptantha flaccida,* June 26, 1929 (P. H. Timberlake); two male, five female paratypes, Lone Pine Canyon, Inyo County, California, 8,000 feet altitude, on *Cryptantha,* June 11, 1937 (C. D. Michener); four female paratypes, Big Pine Creek, Inyo County, California, June 12, 1942 (R. M. Bohart); one male paratype, north fork of Bishop Creek, Inyo County, California, 8,500 feet altitude, June 22, 1937 (C. D. Michener). One female, Mill Creek, San Bernardino Mountains, 6,000 feet altitude, on *Cryptantha micrantha* var. *lepida,* July 2, 1944.

The holotype and allotype are in the Snow Entomological Collections.

Proteriades pygmaea new species

This species is similar to *nanula* but is slightly smaller, with abundant white pubescence, broad white hair-bands on abdomen and clearer wings. In both sexes the head is declivous closer behind the ocelli than in *nanula* so that the posterior ocelli are closer to the posterior margin of the vertex.

Male: Black, the abdomen ferruginous red, with a dark basal spot at middle of second and third terga and a larger infuscation on middle of fourth and fifth terga; sixth infuscated basally; seventh entirely infuscated. Apical margins of terga, especially of the sixth and seventh, testaceous. Mandibles testaceous red, a little dusky at base, and clearer red at apex, the teeth piceous. Flagellum and tarsi reddish brown, the claws ferruginous. Tibial spurs yellowish white. Tegulae pale amber color. Wings nearly clear hyaline, the stigma and nervures brownish. Head as long as wide, the inner orbits slightly converging below. Genal areas more than half as wide as eyes, seen from side. Clypeal truncation broader than labrum, margin impunctate, crenulate, not thickened. Outer tooth of mandibles much longer and more acute than inner tooth. Distance from posterior ocelli to nearest eye margin somewhat less than distance between posterior ocelli; distance from posterior ocelli to edge of vertex still less, being about as great as ocellar diameter. Antennae short, middle segments of flagellum as long as thick. Middle coxae not toothed; posterior coxae not lamellate. Sixth tergum with a small obtuse tooth on each side. Seventh tergite shallowly emarginate on each side to form the apical process, lateral angulation broadly rounded; apical process moderately wide and only slightly notched medially, so that the margin is scarcely bilobed. Venter as in *nanula* except that the apical fringe is well developed on second sternum as well as on third to fifth sterna. Head and thorax closely punctured, the punctures rather coarse in relation to the small size of the insect. Punctures of clypeus and frons one puncture-width, or less, apart, and those on vertex, especially between and behind the ocelli, becoming more separated. Punctures of mesoscutum mostly somewhat more than a puncture-width apart, and more widely separated just mesad of parapsidal lines. Punctures of mesopleura about as close as those of mesoscutum. Abdomen minutely and closely punctured. Pubescence white, long and dense on face, cheeks, sides of thorax, margins of mesonotum, posterior sides of front and middle femora and on posterior margins of hind tibiae. First four metasomal terga each with a white apical

hair-band, but these bands much less broad and dense than in female (and easily worn so that they are usually missing). Apical terga covered with moderately dense, appressed, white hair. Length, 3 to 3.5 mm.; fore wing, 2.6 to 2.8 mm.

Female: Similar to male. Black, the first three metasomal terga ferruginous red, with base of first and middle of second and third more or less clouded with blackish. Apical margin of fourth and fifth terga rufo-testaceous. Tarsi generally more blackish than in male. Venter more or less reddish, but suffused with black on apical segments. Mandibles moderately expanded at apex, inner margin emarginate near base; the three teeth almost equally spaced, acute, but decreasing in size from outer to inner tooth. Antennae short, the middle segments of flagellum as long as thick. Genal areas about two thirds as wide as eyes, seen from side. Distance between posterior ocelli greater than distance to eye margin or to edge of vertex. Clypeus slightly and evenly convex at base and depressed apically, the apical margin obtusely angulate at sides and subtruncate or broadly rounded medially, the whole having the appearance of being strongly rounded out; angles limiting ends of truncation more distinct than in *nanula,* distance between these angles and sublateral angles much less than distance from latter to eye margins; clypeal margin between sublateral angles and ends of truncation slightly concave. Maxillary palpi short, with four nearly equal, closely joined segments. Pubescence white, unusually dense and mostly subappressed, that on the face extending more than halfway upward between insertion of antennae and the ocelli, and that on apex of scutellum more erect than elsewhere. Dense hair covers the face, genal areas, margins of mesonotum, sides of thorax, posterior surfaces of front and middle femora, anterior surfaces of hind coxae and femora, and outer sides of hind tibiae. First three metasomal terga each with a broad white apical hair-band, broadening toward each side on first tergum. Three apical terga covered with rather dense appressed white hair, becoming a little denser and somewhat bandlike at apices of fourth and fifth terga. Ventral scopa short and whitish. Length, 3.25 to 4.0 mm.; fore wing, 2.5 to 2.8 mm.

Holotype male, allotype female and one male and two female paratypes, La Quinta, west of Indio, Riverside County, California, on *Cryptantha barbigera,* March 4, 1936 (P. H. Timberlake). One female paratype, Palm Springs, Riverside County, California, on same flower, March 30, 1945 (P. H. Timberlake); one female para-

type, seven and one half miles south of Twenty-nine Palms, Riverside County, California, on *Nama demissum,* May 7, 1948 (P. H. Timberlake); one male, four female paratypes, two miles south of Cathedral City, Riverside County, California, on *Cryptantha,* April 10, 1936 (C. D. Michener); one female paratype, five miles east of Cathedral City, on *Cryptantha,* April 10, 1936 (E. G. Linsley); and one male paratype, Panamint Springs, Inyo County, California, on *Cryptantha,* April 7, 1938 (E. G. Linsley).

The holotype and allotype are in the collection of the Citrus Experiment Station, Riverside, California.

Proteriades basingeri new species

This species in the male differs from others, except *P. boharti,* in having a low rounded protuberance at the apex of the first metasomal sternum. It differs from *boharti* in having shorter antennae and a shining punctureless border at the apex of the clypeus, as well as by lacking lamellae on the posterior coxae. It is quite possible that this is the male of *similis,* but *basingeri* has never been collected with that species, although they are from the same locality. Circumstances suggesting the association of the two as sexes of one species are their small size, and the fact that each is known only from Riverside where both are very rare.

Male: Black, the abdomen ferruginous, with last two terga and middle of preceding two or three segments more or less suffused with fuscous. Sterna almost entirely ferruginous. Mandibles reddened on apical half, teeth blackish, flagellum and tarsi brownish, the claws ferruginous. Tegulae dark amber color. Wings dusky hyaline, the stigma and veins fuscous. Head as broad as long, the genal areas about two thirds as broad as the eyes. Inner orbits slightly converging below. Antennae short, the scape slender and short, the middle segments of flagellum about as long as broad. Clypeal truncation broader than width of labrum, the margin slightly thickened, impunctate, weakly crenulate. Teeth of mandibles acute, the outer one somewhat longer than inner. Distance between posterior ocelli a little less than distance from one of them to edge of vertex or to eye margin. Middle coxae each with blunt ventral tooth in front of base of trochanter. Posterior coxae not lamellate. Sixth tergum distinctly angulate at sides. Lateral margins of seventh tergum strongly angulated before apex, apex broad and bilobed. First sternum of metasoma with a medio-apical low rounded proturbance. Second sternum with a weak transversely

arcuate subapical swelling, its apical fringe rather thin. Fringes of third and fourth sterna long and dense, that of fifth shorter and very dense, all of these conforming to the broadly emarginate apical margins of the sterna; sixth sternum with the usual longitudinal median ferruginous fold. Head and thorax finely and closely punctured, the punctures sparser and a little coarser on the mesopleura than elsewhere. Punctures of clypeus minute and dense, but leaving a shining, nearly punctureless apical border. Abdomen minutely and closely punctured. Pubescence whitish, or sometimes brownish ochreous on middle of face and on the mesonotum, dense on clypeus and face, moderately dense elsewhere on head and thorax, except on upper part of supraclypeal area, vertex and disk of mesoscutum, which are well exposed; hair of these parts very short, with a few longer erect hairs interspersed. Hair of abdomen fine and short, not forming apical hair-bands, but denser on the apical segments and becoming much longer along the lateral margins. Length, 4.6 to 5.5 mm.; fore wing, 3.2 to 3.8 mm.

Holotype male: Riverside, California, April 11, 1933 (A. J. Basinger). One male paratype, same locality, April 4, 1939, on ground (P. H. Timberlake); one male paratype, same locality, on *Cryptantha intermedia,* March 20, 1929 (P. H. Timberlake).

The holotype is in the collection of the Citrus Experiment Station, Riverside, California.

Proteriades reducta new species

The male of *reducta* is distinguishable from similar middle-sized species by having the middle of the first sternum of abdomen covered with conspicuous white hair and by lacking the ventral tooth of the middle coxa which is present in allied species. The female differs from *truncauda* in the slightly smaller size and by having the first three terga entirely red and clypeal margin more truncate medially. From *bidenticauda* it differs in having the maxillary palpi shorter, with only two or three indistinct segments, and the clypeal margin without a notch just within the lateral angulations. These three species differ from *hamulicornis* and *seminigra* in having the frons more shining and less closely punctured.

Male: Black, the first four metasomal terga ferruginous red, except base of first and sometimes a median spot or stain on the others. Fifth tergum (sometimes) stained with red, its apical margin and that of fourth and sixth terga broadly testaceous. Mandibles largely red but more or less dark at extreme bases and apices.

Flagellum and tarsi dark brown. Tegulae amber color. Wings dusky hyaline, the stigma and veins dark brown. Head about as broad as thorax, genal areas about three fourths as broad as eyes, the inner orbits slightly converging below. Posterior ocelli a little closer together than the distance to eye margin or to edge of vertex. Clypeal truncation broad, very gently concave, not crenulate, not thickened, slightly broader than labrum, demarked by distinct angles. Mandibular teeth acute, outer distinctly longer and sharper than inner. Maxillary palpi short with two or three indistinct segments. Antennae short, the middle segments of flagellum as long as thick, the scape only slightly swollen. Middle coxae not toothed, posterior coxae not lamellate. Sixth metasomal tergum with a small distinct tooth on each side. Lateral margins of seventh tergum strongly and broadly incised before the apex to form a strong but blunt angulation. Apical process moderately wide and indented medially to form two rounded lobes. First sternum with a triangular medio-apical area somewhat protuberant and densely covered with rather long white hair, which also fringes the margin. Apical fringe of second to fourth sterna long and rather dense, fifth broadly emarginate at apex, its apical fringe short, sixth also provided with a short apical fringe, as well as the usual median rufo-testaceous fold which is sharp only posteriorly and broad and covered with short hairs anteriorly. Head and thorax finely and very closely punctured, the punctures becoming more separated on the mesopleura. Punctures of abdomen minute and close. Pubescence white, moderately dense, becoming denser on clypeus and face nearly to level of ocelli. Clypeal brush shortening anteriorly and anterior margin of clypeus narrowly exposed. Pubescence of abdomen thin, short and whitish, forming only traces of bands on the basal segments. Length, 5.0 to 5.5 mm.; fore wing, 3.8 to 4.0 mm.

Female: Black, the first three metasomal terga and sides of the fourth more or less broadly, ferruginous red, fourth and fifth terga with posterior margins broadly rufo-testaceous. Mandibles red subapically. Tegulae translucent brown. Head as wide as thorax, inner orbits slightly converging below, genal areas about three fourths as wide as eyes seen from side. Distance between posterior ocelli subequal to distance from one of them to eye margin, slightly greater than distance to posterior edge of vertex. Mandibles constricted near base and moderately expanded at apex, the teeth acute, with the innermost one much shorter and a little more distant from the middle tooth than the latter is from the outer tooth. Disk of

clypeus moderately convex basally and subdepressed toward the apex, apical margin broadly truncate in middle, the truncation slightly longer than the oblique sides, not thickened, scarcely impunctate, demarked by distinct angles; sublateral angles closer to the ends of the truncation than to margin of eyes, clypeal margin between sublateral angles and ends of truncation slightly concave. Puncturation of head and thorax fine and close but less dense than in the male, or than in *seminigra* and *hamulicornis*. Pubescence white and moderately developed, the vertex and disk of mesoscutum well exposed. Abdomen with thin, short, appressed whitish hair, becoming a little denser on apical segments, and forming narrow apical bands at sides of the first three terga. Scopa yellowish white. Characters otherwise agreeing with male. Length, 4.5 to 5.0 mm.; fore wing, 3.2 to 3.4 mm.

Holotype male: Riverside, California, on *Cryptantha intermedia*, May 15, 1935 (P. H. Timberlake). Allotype female, April 15, 1939, data otherwise the same. Two paratypes with same data except that one (male) was collected May 15, 1926; the other (female), April 26, 1926. One paratype 1.5 miles west of Perris, Riverside County, California, May 14, 1946 (P. H. Timberlake).

The holotype and allotype are in the collection of the Citrus Experiment Station, Riverside, California.

Proteriades cryptanthae new species

This species is nearly of the same size and color as *semirubra*. It is easily distinguished in the male from all other species except *caudex* by having a large hornlike process on the apical middle of the first metasomal sternum. The male differs from *caudex* in the larger size and in having the ventral process thin-edged and truncate at apex. From *semirubra* the female differs in having the hair-bands of abdomen little developed, and the clypeal margin without fingerlike processes.

Male: Black, the first four terga of abdomen red; fourth tergum (often) with a large median infuscation or subapical cross band (third tergum more rarely with a dark cross band). Apical margins of fifth and sixth terga rufo-testaceous. Apical segments of tarsi rufous (or brown). Mandibles with a subapical dark red blotch on band. Flagellum moderately reddened beneath. Tegulae fuscous, slightly reddened. Wings strongly dusky, stigma and veins piceous. Head as broad as thorax, broader than long; genal areas two thirds as wide as eyes seen from side. Distance between posterior ocelli

less than distance from one of them to eye margin or to posterior margin of vertex. Clypeal margin with truncation about as broad as labrum, and defined by distinct angles, the margin of truncation slightly thickened, impunctate, and feebly produced medially and sublaterally. Maxillary palpi four-segmented. Antennae shorter than in *semirubra,* the middle segments of flagellum scarcely longer than thick. Middle coxae each with a slight ventral swelling but without a tooth; posterior coxae not lamellate, but carinae very strong. Sixth tergum with a tooth on each side, seventh with a larger and sharper tooth on each side, beyond which is a broad emargination, and with the median lobe moderately wide and truncate at apex, with only a trace of a median emargination. (In *semirubra* the median lobe is considerably broader and distinctly emarginate, and the lateral teeth are smaller and much closer to apex of median lobe.) First metasomal sternum with a large vertically descending process from its apex, this process convex in front, flat behind, and thin-edged and truncate at apex. Second, third, and fifth sterna each with apical fringe, that on third becoming denser at the middle, those on second and third long, and that on fifth rather short, very dense, and conforming to the broadly emarginate margin of the segment; fourth sternum with only a sparse fringe. Head and thorax finely and very closely punctured, the punctures becoming slightly more separated on scutellum, and larger and more separated on mesopleura. Abdomen minutely and closely punctured, the punctures less crowded toward the base. Pubescence white, moderately dense on head, thorax and legs, and leaving vertex and disk of mesoscutum well exposed. Hair of face sometimes tinged with pale brown, and covering surface nearly to level of ocelli, the clypeal beard, however, less dense than in *semirubra.* Abdomen with fine short hair, most dense on apical margins and forming weak bands laterally on first four metasomal terga. Length, 6.0 to 7.0 mm.; fore wing, 4.2 to 5.0 mm.

Female: Black, with first three metasomal terga, base of fourth and apical margins of fourth and fifth red; sterna black. Mandibles red apically and along the inner margin. Coloration otherwise as in male. Head large, as broad as thorax, genal areas considerably broader than eyes seen from side and broadest just above middle of eyes. Mandibles not much narrowed toward bases, inner margins a little emarginate near bases, much less broad at apices than in *semirubra,* with the three teeth acute, the outer one a little longer and more acute than the others. Clypeus rather strongly convex,

its apical margin somewhat depressed; truncation broad, demarked by distinct angles which are (usually) farther apart than distance from one of them to eye margin; margin of truncation thick, crenulate with about four to six small blunt teeth, and projecting but little over the base of labrum. Distance between posterior ocelli less than distance from one of them to nearest eye margin and subequal to distance to edge of vertex. Puncturation nearly as in the male. Pubescence whitish, much less dense on the face than in the male. Ventral scopa short, tinged with ochraceous. Length, 6.4 to 7.5 mm.; fore wing, 4.0 to 4.7 mm.

Holotype male: Riverside, California, on *Cryptantha intermedia,* April 18, 1928 (P. H. Timberlake). Allotype female: same data except collected April 23, 1928. Nine male and eight female paratypes, same data except males taken March 21 to May 1, females April 20 to June 17; one female paratype, the Gavilan, Riverside, County, California, April 16, 1939; one female paratype, six miles east of Temecula, California, May 9, 1936; two female paratypes from Claremont, Los Angeles County, California, May 4, 1945; all on flowers of *Cryptantha intermedia* except one rescued from a spider and all collected by P. H. Timberlake; one additional female paratype from Newhall, Los Angeles County, California, April 20, 1941 (R. M. Bohart, in the Bohart collection).

The holotype and allotype are in the collection of the Citrus Experiment Station, Riverside, California.

Proteriades caudex new species

In the male this species resembles the considerably larger *cryptanthae* by having a very large protuberance on the first sternum; it differs from *cryptanthae* by having this sternal process thick and stumplike instead of flattened antero-posteriorly and thin-edged at apex. The posterior coxae are lamellate, a character not shared by *cryptanthae.* The female is far less distinctive but can be recognized by the narrow truncation of the clypeus, on each side of which is a distinct concavity between the end of the truncation and the sublateral angle.

Male: Black, first three abdominal terga red, the basal concavity of the first infuscated, the second with an infuscated dorsal patch, the third with a rather large (or sometimes small) dorsal black patch, the fourth broadly red laterally. Third to sixth terga with posterior margins testaceous. Mandibles reddish subapically (or largely red). Flagellum brown, paler beneath. Tegulae dark amber color. Wings

slightly dusky, veins and stigma blackish. Head as broad as thorax, broader than long. Genal areas about two thirds as broad as eyes seen from the side. Distance between posterior ocelli slightly less than (to slightly more than) distance from one of them to eye margin and to posterior edge of vertex. Inner orbits slightly converging below. Antennae long, scape slightly swollen, flagellar segments all longer than broad, middle ones nearly twice as long as broad. Clypeal truncation wider than labrum, demarked by distinct singles, margin of truncation impunctate but not thickened, slightly crenulate. Mandibles with teeth acute, inner one but little shorter than outer. Middle coxae not toothed. Posterior coxae each with carina gradually expanded posteriorly to form a low lamella, the posterior end of which is produced to a rounded apex slightly beyond the end of the rest of coxa. Sixth metasomal tergum with a small acute angle on each side. Seventh with a large bluntly rounded basal angle on each side, distad to which margins of tergum are deeply emarginate, apical produced portion of tergum with conspicuous median emargination somewhat broader than the resulting lobes. First sternum with a very large median apical protuberance with a rounded apex. Second to fifth sterna with apical fringes, those of second to fourth very long, conforming to the emarginate posterior edges of the sterna. Fifth sternum with the usual ferruginous fold. Punctation rather fine and dense, coarser and sparser on mesepisterna. Pubescence white, ochraceous on dorsum of head and thorax, dense on face nearly to level of anterior ocellus, forming only very feeble abdominal bands on first five metasomal terga. Length, 4.5 to 5.8 mm.; fore wing, 3.4 to 3.8 mm.

Female: Black, first metasomal tergum red except black area in basal concavity and posterior median black (or infuscated) area (sometimes connected to black area of concavity); second and third terga with lateral thirds or slightly more red (fourth often red at sides basally, occasionally with red extending to apex at extreme sides). Coloration otherwise as in male. Head as broad as thorax, as broad as long. Genal areas over two thirds as broad as eyes seen from side. Distance between posterior ocelli subequal to distance from one of them to posterior edge of vertex, (usually) slightly less than distance to eye margin. Inner orbits converging below. Clypeus uniformly gently convex, upper part not noticeably bulging, marginal truncation only about two thirds as long as distance from one of the angles limiting it to lateral angle of clypeus, sublateral angles nearer to angles limiting truncation than to lateral angles,

margin between sublateral angles and angles limiting truncation conspicuously concave. Mandibles narrowed near bases by the usual emargination in inner margin of each, teeth equidistant, all acute. Maxillary palpi three- or obscurely four-segmented. Punctation fine, that of clypeus coarser than that of rest of head, about as coarse as that of posterior part of mesoscutum, portions of latter mesad of parapsidal furrows not noticeably more coarsely punctate than rest of scutum; mesepisterna conspicuously more coarsely punctate than mesoscutum. Pubescence as in male but not so dense on face, sparsely covering fifth and sixth terga, bands on first four terga more conspicuous; scopa white. Length, 4.6 to 5.5 mm.; fore wing, 3.0 to 3.4 mm.

Holotype male: Idyllwild, San Jacinto Mountains, California, May 23, 1940 (C. D. Michener). Allotype female: Pine Flat, near Idyllwild, San Jacinto Mountains, California, on *Cryptantha micrantha,* June 15, 1940 (C. D. Michener). Five male paratypes, same data as holotype but collected May 26, 1940; one male paratype, Herkey Creek; San Jacinto Mountains, California, June 4, 1940 (C. D. Michener). One female and four male paratypes, Keen Camp, San Jacinto Mountains, California, on *Cryptantha,* May 16, 1939 (E. G. Linsley); seven female paratypes, same data as allotype; one female paratype, Idyllwild, San Jacinto Mountains, California, June 3, 1939, on *Cryptantha lepida* (P. H. Timberlake); two female paratypes, Santa Rosa Mountain, San Jacinto Mountains, California, on *Cryptantha micrantha,* May 31 and June 8, 1940 (C. D. Michener); one female paratype, San Jacinto Mountains, California, 1912 (J. C. Bridwell).

The holotype and allotype are in the Snow Entomological Collections.

Proteriades bidenticauda new species

Hoplitina hesperia, Cockerell, 1926, Pan-Pac. Ent., 3: 87 (male, misidentification).

The male of this species is readily recognizable among *Proteriades* species by the seventh metasomal tergum, the two lobes of which have become two blunt teeth separated by a long straight margin. A superficially similar configuration occurs in the unrelated species *deserticola,* but in that form the teeth are separated by a concave margin. The female is similar to several other species such as *hamulicornis,* from which it differs in the closely punctured clypeus among other characters.

Male: Black, abdomen red, basal concavity largely black, (fourth tergum often with an infuscated spot dorsally), fifth to

seventh terga brownish or infuscated; posterior margins of fourth to sixth terga broadly testaceous. Mandibles largely rufescent, red subapically. Antennal flagellum brown, paler beneath. Tarsi brown, paler distally. Tegulae light amber color. Wings scarcely dusky, veins and stigma brownish black. Head as wide as thorax; genal areas about two thirds as broad as eyes seen from sides; distance between posterior ocelli greater than distance from one of them to posterior edge of vertex, much greater than that to eye margin. Inner orbits of eyes parallel. Antennae with basal flagellar segments broader than long, middle segments about as long as broad, distal ones longer than broad. Clypeal truncation broader than labrum, broadly thickened, gently concave, not crenulate (or slightly crenulate), limited by distinct angles. Mandibles with teeth acute, inner one not much shorter than outer. Hypostomal carinae very low. Maxillary palpi four-segmented. Middle coxae each with a small tooth in front of base of trochanter. Hind coxae not lamellate. Sixth metasomal tergum with obtuse angle at each side. Seventh tergum with lateral margins straight, extending backward to form two blunt teeth widely separated by a margin which is nearly straight. First sternum somewhat thickened, posterior margin declivous. Second, third, and fourth terga with apical fringes, particularly long on third and fourth and conforming to the emarginate edges of these two terga. Second sternum with a shining convexity at each side, third with small convexities of the same sort. Fifth sternum produced to a thin, transparent, unfringed margin. Sixth sternum with the usual ferruginous fold, the lower edge of which is broadened and covered with short hairs. Punctation rather fine, particularly fine and close on clypeus except for the impunctate margin; central part of mesoscutum between parapsidal lines more coarsely and less closely punctate than rest of mesoscutum; mesepisterna a little more coarsely punctate. Pubescence sparse, white, covering face to level of antennal bases, not forming abdominal bands. Length, 5.0 to 5.5 mm.; fore wing, 3.4 to 3.8 mm.

Female: Black, first four metasomal terga red, the first with black in basal concavity, the third (and often the second, sometimes first as well) with infuscated dorsal spot, fourth with black patch dorsally and sometimes infuscated laterad of this patch; fourth and fifth terga with posterior margins broadly rufo-testaceous. Coloration otherwise as in male. Head as broad as thorax, slightly broader than long. Genal areas nearly as broad as eyes seen from side. Distance between posterior ocelli greater than distance from one of

them to eye margin or posterior edge of vertex. Inner orbits slightly converging below. Clypeus with upper two thirds somewhat bulging, lower third depressed; truncation defined by rather obscure angles, about as long as distance from end of truncation to lateral angle of clypeus, sublateral angles slightly nearer to ends of truncation than to lateral angles, margins between ends of truncation and sublateral angles slightly concave. Mandibles narrow near the base because of the usual emargination of the inner margin, tridentate (with the teeth blunt in most specimens probably because of wear). Maxillary palpi four-segmented. Punctation fine, that of clypeus close and but little coarser than that of rest of head. Punctures of convexities in front of ocelli slightly sparser than those of adjacent areas. Mesoscutum with an ill-defined zone of coarse and widely separated punctures between parapsidal furrows, as in male; punctures of mesepisterna but little coarser than those of this zone. Pubescence sparse, white, forming only very weak apical bands at sides of first four metasomal terga; fifth and sixth terga sparsely covered with white pubescence. Length, 4.8 to 5.4 mm.; fore wing, 2.8 to 3.6 mm.

Holotype male, allotype female: Mazourka Canyon, Inyo Mountains, Inyo County, California, 9,500 feet altitude, June 1, 1937 (C. D. Michener). Seven male and one female paratypes, same data; two male paratypes, same locality, 8,000 feet altitude, May 22, 1937; seven male and two female paratypes, same locality, 7,500 feet altude, May 21, 1937, one on *Cryptantha;* four male and one female paratypes, same locality, 7,000 feet altitude, two on *Cryptantha;* one male and two female paratypes, Wild Rose Canyon, Panamint Mountains, Inyo County, California, 7,000 feet altitude, May 27, 1937; one female paratype, Tuber Canyon, Panamint Mountains, Inyo County, California, 8,000 feet altitude, June 18, 1937 (all C. D. Michener, collector); two male paratypes from the type locality (no altitude record), May 21, 1937 (N. W. Frazier); two male paratypes, Inyo Mountains, Inyo County, California, June 1, 1937 (E. C. Van Dyke); one male paratype, Silver Canyon, White Mountains, Inyo County, California, May 11, 1926 (J. O. Martin).

The holotype and allotype are in the Snow Entomological Collections.

This species emerges in early spring in the high desert ranges where it occurs and almost all the specimens collected were found resting on rocks or sand before the *Cryptantha* flowers were open.

Proteriades truicauda new species

In this moderate sized species the male is very readily recognized by the much produced, scoop-shaped seventh metasomal tergum which is not at all bilobed and not angulate on the sides. The female is markedly smaller than the male and differs from a series of structurally rather similar species such as *tristis* and *reducta* by having the red coloration restricted to the sides of the metasomal terga but exending back to the fifth or sixth tergum.

Although as the specimens were collected it was felt that the males and females represented a single species, we subsequently doubted this because the males were so much larger than the females. However, males are larger than females in several other species of *Proteriades* (e. g. *xerophila, deserticola*). The males and females here united under the name *truicauda* agree in having red extending far back on the sides of the abdomen but restricted dorsally, in the broad translucent rufo-testaceous margins of the metasomal terga, in the segmentation of the maxillary palpi, and in having the punctation a little coarser than in allied species.

Male: Black, the metasomal terga light red laterally; first three terga with dark brown or blackish dorsal area, occupying dorsal half of each tergum, so that the lateral quarters are red, these dark dorsal areas narrowed anteriorly on each segment, and terminated posteriorly by the broad translucent rufo-testaceous margin of each segment; fourth tergum similar but with dark area extending farther toward each side; fifth and sixth with dark areas not narrowed anteriorly and nearly reaching lateral margins, the red that is present heavily infuscated on sixth, the posterior margins broadly rufo-testaceous as on preceding terga; seventh tergum wholly dark red, heavily infuscated in certain areas. Abdominal sterna black. Mandibles faintly reddish subapically. Antennal flagellum, tarsi, apices of tibiae and apices of femora dark brown. Tegulae transparent, pale honey color, appearing dark only because of dark sclerites beneath them. Wings dusky hyaline, the veins and stigma black. Head as wide as thorax, slightly broader than long. Genal areas about two thirds as wide as eyes seen from side. Eyes somewhat swollen, inner orbits slightly converging below. Margin of clypeal truncation slightly thickened, broadly impunctate, strongly crenulate because of five or six small projections which are largest medially, truncation broader than labrum, demarked by distinct rounded angles. Distance between posterior ocelli subequal to distance from one of them to eye margin, slightly less than distance

from one of them to posterior margin of vertex. Mandibular teeth subequal, outer tooth sharper than inner. Maxillary palpi short, tapering, four-segmented. Antennae long, flagellar segments except the first longer than broad. Hypostomal carinae very low. Middle coxae each with ventral angle in front of base of trochanter. Posterior coxae not lamellate. Sixth metasomal tergum with a small distinct tooth at each side. Seventh tergum large, much excerted with a middorsal depressed area, under surface strongly concave. Lateral margins straight (or nearly so), apical margin slightly convex (to nearly straight). First metasomal sternum thinly haired, the pubescence denser posteriorly; posterior margin of sternum strongly thickened and considerably elevated above second sternum. Second sternum large, with a strong shining convexity at each side, fringe long, sparse medially. Third sternum with small convexities at each side and a long fringe. Fourth sternum with posterior edge broadly emarginate, the shorter fringe conforming to the emargination. Fifth sternum similarly emarginate, practically without a fringe. Sixth sternum with the reddish median fold, sharp posteriorly, broad and covered with short hairs anteriorly. Head and thorax rather finely punctured, clypeus and lower two thirds of supraclypeal area very finely and closely so, vertex with punctures separated by nearly a puncture width, much of mesoscutum with punctation similar to that of vertex but areas mesad of parapsidal furrows with much coarser and more widely separated punctures; mesepisterna with even coarser and more widely separated punctures; abdomen rather finely punctured. Pubescence (badly worn) whitish, sparse, not completely covering surface even on clypeus, not forming abdominal bands. Length, 6.5 to 7.5 mm. (abdomen strongly curled under); fore wing, 4.1 mm.

Female: Black, the sides of the abdominal terga red, most broadly so on the first tergum and decreasingly so toward apex, so that the sixth tergum is nearly all black. Depressed apical margin of first fine terga pale testaceous. Mandibles dark red in apical half. Antennae and tarsi dark, the claws and apices of femora and tibiae ferruginous. Tegulae pale translucent amber. Wings dusky hyaline, the stigma and veins blackish. Head about as broad as long and broader than thorax. Inner orbits of eyes slightly converging below. Posterior ocelli about as far apart as distance to edge of vertex, and the distance from either to nearest eye margin slightly greater. Disk of clypeus moderately convex and a little depressed toward the apex, the punctures leaving a narrow smooth

space across apical margin. Margin of clypeus so weakly angulated at sides and so weakly truncate in middle that it appears well rounded out, sublateral angles very close to angles limiting end of truncation and separated from them by a small emargination. Mandibles constricted by an emargination of the inner margin near the base, moderately expanded at apex, the two outer teeth subequal and moderately acute, the innermost tooth nearly rectangular and separated from the middle tooth by a rounded emargination. Maxillary palpi short, tapering, four-segmented. Head and thorax rather closely punctured, the punctures coarser and sparser on the mesepisterna than elsewhere. Punctures on middle of mesoscutum less than a puncture width apart, areas mesad of parapsidal lines more coarsely and sparsely punctured. Pubescence whitish, moderately dense on face, cheeks and thorax, with the vertex and disk of mesoscutum well exposed. First to fourth terga each with a rather broad white apical hair-band, and disks of fifth and sixth terga thinly covered with appressed whitish hair. Length, 5.5 to 6.0 mm.; fore wing, 4.0 mm.

Holotype male: Santa Rosa Mountain, San Jacinto Mountains, Riverside County, California, on *Cryptantha micrantha,* June 8, 1940 (C. D. Michener). Allotype female, same locality, June 18, 1940 (C. D. Michener). Two male and two female paratypes, all from the same locality and on the same flower, one of each sex May 31, 1940 (C. D. Michener) and one of each sex June 8, 1940 (P. H. Timberlake).

The holotype and allotype are in the Snow Entomological Collections.

Proteriades hamulicornis new species

The male of this species is easily recognizable by numerous characters such as the very broad face with the inner orbits diverging below, the sharply pointed last antennal segment suggestive of this structure in *Hoplitis,* subgenus *Alcidamea,* and the spined posterior coxae. By contrast, the female, which is apparently to be associated with these males, is unspecialized in structure and similar to several other species, such as *bidenticauda.* It differs in having the prominences in front of the ocelli densely punctured without shining interspaces and in the widely separated punctures of the convex upper portion of the clypeus.

Male: Black, first three metasomal terga red except concavity of first which is black, and longitudinal median infuscated streak on third (and sometimes second). Fourth to sixth terga with broad

rufo-testaceous (or sometimes translucent testaceous) posterior margins, the fourth also (usually) red laterally and basally. Mandibles red subapically and along inner margins (or very largely red). Antennal flagellum brown, pale brown beneath. Tegulae testaceous, infuscated anteriorly. Legs brownish black, tarsi brown, lighter toward apices. Wings slightly dusky, veins and stigma brownish black. Head slightly broader than thorax, much broader than long, inner orbits slightly diverging below, more strongly so in lower thirds. Genal areas nearly two-thirds as wide as eyes, seen from sides. Distance between posterior ocelli subequal to distance from one of them to eye margin and to posterior edge of vertex. Antennae rather long and thickened; scape swollen, pedicel unusually large; flagellum progressively thickened toward apex, subapical segment broadest, most of the segments slightly longer than broad, apical segment drawn out into a slender curved point as in *Hoplitis*, subgenus *Alcidamea*. Clypeus very short and broad, three times as broad as long, scarcely overhanging base of labrum; anterior margin between lateral angles of clypeus scarcely produced; truncation about as wide as labrum, limited by very weak angles, its margin thickened and very feebly crenulate or wavy. Mandibles narrowed at apices so that the two teeth are crowded together, outer tooth much longer than inner but both acute. Hypostomal carinae very low and inconspicuous except where each is elevated to a tooth at angle. Maxillary palpi three-segmented, last segment longer than either of the others and sometimes with a feeble constriction indicating division into two segments. Middle coxae not toothed although slightly swollen in front of bases of trochanters. Posterior coxae with inner surfaces broadly concave, carinae scarcely evident; inner apical portion of each posterior coxa prolonged into a long spine. Sixth metasomal tergum of male with a small angle at each side. Seventh tergum with a broad emargination on each side, an obtuse rounded angle basad of emargination; median portion of tergum produced, notched medially forming two broad lobes. First metasomal sternum without a protuberance, thickened, its posterior margin abruptly declivous. Second sternum but briefly fringed; third to fifth with long conspicuous fringes; sixth sternum with the usual reddish median fold, the summit of which is flattened and provided with short hairs. Punctuation fine and dense, coarser on posterior part of mesoscutum, on scutellum, and mesepisterna than on vertex. Pubescence white, covering face nearly to level of anterior ocellus (or worn off above antennae); hypostomal areas

densely pubescent; abdominal bands virtually absent. Length, 4.8 to 5.2 mm.; fore wing, 3.0 to 3.5 mm.

Female: Black, first three metasomal terga red, concavity of first black (third sometimes with an infuscated dorsal patch). Fourth tergum red basally (sometimes also laterally). Fourth and fifth terga testaceous posteriorly. Anterior margin of clypeus red. Coloration otherwise as in male. Head about as wide as thorax, as long as broad. Genal areas about three fourths as wide as eyes seen from side. Distance between posterior ocelli subequal to distance from one of them to posterior edge of vertex, slightly less than (or subequal to) distance to eye margin. Inner orbits very slightly converging below. Clypeus convex, lower fourth depressed. Clypeal margin with truncation rather narrow, angles delimiting it weak, distance between these angles less than distance from one of them to lateral angle; sublateral angles more distinct and closer to angles demarking truncation than to lateral angles, margin on each side of each sublateral angle gently concave. Mandibles narrowed subbasally by a broad emargination of the upper margin, as usual in the group; teeth acute, although upper one scarcely so. Hypostomal carinae and antennae of the usual type. Head and thorax finely punctured except for clypeus which is more coarsely so with the punctures of the upper convex portion separated by fully their diameters; punctures of prominences in front of ocelli as close as those of supraclypeal area and vertex; punctures mesad of parapsidal furrows not coarser or sparser than those of other areas of mesoscutum; punctures of mesepisterna not coarser than of mesoscutum. Pubescence white, dense on paraocular areas and around antennal bases, forming feeble apical bands on sides of first four metasomal terga, and partially covering surfaces of fifth and sixth terga. Scopa whitish. Length, 4.0 to 5.0 mm.; fore wing, 3.0 to 3.4 mm.

Holotype male: Mazourka Canyon, Inyo Mountains, Inyo County, California, 7,500 feet altitude, May 21, 1937 (C. D. Michener). Allotype female, same data, on *Cryptantha.* One male paratype, same locality, 7,000 feet, May 20, 1937, on *Cryptantha;* one male and one female paratype, same locality, 9,500 feet, June 1, 1937 (all C. D. Michener); one male paratype, same locality and date but labeled merely Inyo Mountains, Inyo County, California (E. C. Van Dyke). A small female specimen (not a paratype) is from Wild Rose Canyon, Panamint Mountains, Inyo County, California, May 27, 1937, 7,000 feet altitude, on *Cryptantha* (C. D. Michener).

The holotype and allotype are in the Snow Entomological Collections.

Proteriades xerophila (Cockerell) new combination

Osmia xerophila Cockerell, 1935, Pan-Pac. Ent., 11: 45.
Anthocopa xerophila Linsley and McSwain, 1942, Amer. Midland Nat., 27: 408.
Anthocopa (Xerosmia) xerophila, Michener, 1943, Ann. Ent. Soc. Amer., 36: 81; Michener, 1949, Jour. Kans. Ent. Soc., 22: 54.

Male: Black, posterior margins of first six abdominal terga testaceous. Antennal flagellum brown, much paler beneath than above. Mandibles red subapically. Apices of femora, bases of tibiae, apices of tibiae and much of tarsi ferruginous; tegulae rufotestaceous. Wings only faintly dusky, veins and stigma dark brown. Head about as broad as thorax. Genal areas two thirds to three fourths as broad as eyes seen from side. Distance between posterior ocelli equal to or slightly less than distance from one of them to posterior margin of vertex, equal to distance to eye margin. Inner orbits very slightly converging below. Antennae long, all flagellar segments markedly longer than broad. Clypeus with lower margin depressed, margin produced to a lobe at each side which extends farther downward than the truncation, the latter nearly as broad as labrum, crenulate. Mandibles with outer tooth but little longer than inner. Maxillary palpi four-segmented. Hypostomal carinae very low. Middle coxae each with a long tooth arising in front of base of trochanter. Sixth metasomal tergum with a small tooth at each side. Seventh tergum with a small but distinct lateral emargination on each side near the apex setting off a distinct short lateral tooth; apical portion of tergum strongly tridentate, the lateral teeth long, parallel, blunt, the median tooth much shorter and sharply pointed; dorsal surface of this tergum largely shining and impunctate. First sternum with a large median apical protuberance, margined by a carina, posterior face of protuberance flattened. Second sternum with an apical fringe which is interrupted medially. Third and fourth sterna with long fringes. Fifth sternum not fringed. Sixth sternum with the usual reddish median fold, the summit of which is flattened; this fold shorter than usual, terminating in a spine; on either side of base of fold is a projecting lobe. Punctation very fine and dense, finer on mesoscutum than on vertex, coarser on mesepisternum. Pubescence dense, white, obscuring surface on lower part of face, forming conspicuous apical bands on first five metasomal terga. Length, 7.2 to 8.8 mm.; fore wing, 5.0 to 6.0 mm.

Female: Coloration similar to that of male. Genal areas broader

than eyes seen from side except in very small specimens where they are equal to eyes in width. Distance between posterior ocelli conspicuously less than distance from one of them to eye margin or to posterior margin of vertex. Inner orbits slightly converging below. Upper portion of clypeus scarcely bulging; truncation as broad as distance from its end to lateral angle of clypeus, demarked by conspicuous angles; sublateral angles nearer to ends of truncation than to lateral angles, margins between sublateral angles and ends of truncation concave. Mandibles broad apically, apical teeth acute, narrowed near bases by the usual broad emargination of inner margin of each. Maxillary palpi four-segmented. Hypostomal carinae high. Punctation fine, that of clypeus coarser than that elsewhere on head and thorax, that of mesoscutum very slightly finer than that of vertex, that of mesepisterna coarser than elsewhere on thorax. Pubescence abundant and white, dense on face, forming conspicuous bands on first four metasomal terga, scattered on fifth tergum, and nearly covering sixth. Length, 6.5 to 8.0 mm.; fore wing, 4.5 to 6.0 mm.

The type of this species, from Palm Springs, Riverside County, California, is in the collection of the Citrus Experiment Station at Riverside, California. A number of other specimens have been collected at the same locality, most of them on *Cryptantha barbigera*, females from March 21 to April 16, males from March 22 to 30 (P. H. Timberlake). Other specimens are from Tub Canyon, Borego, San Diego County, California, February 28, 1947, and Borego, March 6, 1947 (Grace H. and John L. Sperry). The species is also known from Little Lake, Inyo County, California.

Proteriades boharti new species

This species is distinguishable at once from all other known *Proteriades* except *caudex* by the male posterior coxae, the inner ventral carina of each of which is expanded posteriorly into a lamella. This species differs from *caudex* by the absence of a large protuberance on the first sternum.

Male: Black, the first four metasomal terga red, the fourth with a black area middorsally, the third with an infuscated middorsal longitudinal streak (or with an infuscated patch); fifth tergum red at extreme sides; fifth and sixth terga with posterior margins rufotestaceous; sterna blackish. Mandibles red subapically, teeth piceous. Antennal flagellum brown, paler beneath. Legs brownish, black. Head as wide as thorax, wider than long. Genal areas about

two thirds as broad as eyes seen from side. Distance between posterior ocelli equal to distance from one of them to eye margin and to posterior edge of vertex. Inner orbits slightly converging below. Antennal scape swollen; flagellar segments longer than broad. Clypeal margin with truncation broader than labrum, very slightly concave, slightly thickened, weakly crenulate, broadly impunctate. Mandibles with inner tooth not greatly shorter than outer, both acute. Hypostomal carinae very low, almost absent in front of angles. Maxillary palpi apparently four-segmented. Middle coxae not toothed but swollen in front of bases of trochanters. Posterior coxae with carinae elevated posteriorly to form a strong lamella on each coxa, each lamella abruptly truncated at its posterior end. Sixth metasomal tergum with a small but distinct angle at each side. Seventh tergum with broad lateral emargination on each side separating basal angle from the median apical portion of the tergum which is conspicuously bilobed by reason of a median emargination. First metasomal sternum with a rounded subapical protuberance. Second to fourth sterna with fringes of long hairs conforming to the broadly emarginate posterior margins. Fifth sternum with the usual reddish fold, the summit of which is flattened and provided with short pubescence, the posterior end of which is produced into a short spine. Punctation fine and dense, that of clypeus finer and denser than rest of head, mesepisterna more coarsely and less closely punctured than mesoscutum, especially below. Pubescence white, ochraceous on vertex and dorsum of thorax, forming feeble abdominal bands which appear to be easily worn off. Length, 4.0 to 5.0 mm.; fore wing, 2.8 to 3.5 mm.

Holotype male: Carrville, Trinity County, California, 2,400 to 2,500 feet altitude, May 22, 1934 (G. E. Bohart). One male paratype, same locality and collector, June 18, 1934.

The holotype is in the California Academy of Sciences, San Francisco, California.

Proteriades deserticola new species

This is a robust, medium-sized species with abundant pale pubescence. It is at least superficially similar to *bidenticauda* in having two teeth on the seventh metasomal tergum of the male. It seems probable, in view of the differences between both males and females, that this condition arose independently in the two species and that the bidentate male abdomen does not indicate close relationship. In *deserticola* the two teeth are separated by a broad crescentiform emargination and in *bidenticauda* by an equally broad quadrate

emargination. The female of *deserticola* has a very distinctive clypeal margin somewhat similar to that of *evansi*, but with the median lobe less arched and more projecting over base of labrum, so that the margin is about equally produced at sides and in the middle.

Male: Black, with first three metasomal terga usually entirely red, except spot at base of first tergum (and more rarely a median spot at base of second and third). Fourth tergum red except broad median black patch; fifth and sixth terga black, red subapically and broadly translucent ferruginous apically. Seventh tergum red. Venter dark, variably suffused with red. Flagellum reddened beneath and tarsi more or less ferruginous apically. Clypeus with a conspicous emargination as wide as labrum and limited by strong angles, a small projection in middle of emargination. Mandibles dark red on apical half, the teeth (sometimes) piceous. Tegulae clear amber color. Wings clear hyaline, the nervures and stigma brown. Head as broad as thorax, the genal areas about half as wide as eyes seen from side. Inner orbits of eyes parallel. Posterior ocelli slightly closer to eye margins than to the occipital margin. Mandibles bidentate, the teeth subequal. Antennae slender, the middle segments of flagellum barely longer than thick. Maxillary palpi four-segmented. Middle coxae not toothed, posterior not lamellate. Sixth metasomal tergum slightly toothed on each side; seventh with a short blunt tooth at apical corners, these teeth separated by a broad crescentiform emargination, the apex being broader than usual. (Broad also in *bidenticauda, truicauda* and *xerophila.*) Second sternum with a broad transverse subapical swelling. Third to fifth sterna each with a slight transverse swelling close to apical margin, the margin and swelling both indented medially. Sixth sternum with high carina-like median fold. Puncturation very fine and close on head and thorax, the punctures of vertex slightly closer than those of mesoscutum. Abdomen slightly dullish, with minute, close, shallow punctures. Pubescence white, dense on head and thorax, with vertex, middle of mesoscutum and middle of propodeum exposed. Vertex and exposed part of mesoscutum with short fine hair (tinged with ochreous brown in fresh specimens). First four metasomal terga each with a broad white apical hair-band, a little narrowed in middle on first two. Fifth and sixth terga nearly uniformly covered with appressed white hair. Second to fifth sterna each with a long white apical fringe, those on third to fifth conforming to the curvature of the margin. Length, 5.0 to 6.0 mm.; fore wing, 3.8 to 3.9 mm.

Female: Similar to the male. Flagellum beneath, except at base, mandibles apically, and three basal metasomal terga ferruginous red, the red usually a little darker than in male. Median sulcus on first tergum and transverse streaks across bases of second and third terga (usually) black. Head as broad as thorax, genal areas nearly equaling the eyes in width as seen from side. Clypeal margin produced nearly equally at sides and in the middle, with the broad shallow emargination on each side of middle slightly bisinuate to form a small vaguely indicated tooth on each side of the bluntly angular median lobe, the latter rather well elevated, slightly projecting over middle of base of labrum and arched as seen from in front. Mandibles very stout, with inner margin parallel to outer, except for a small emargination in inner margin near base; the two outer apical teeth acute, inner tooth much shorter and only slightly acute, forming nearly a right angle with inner margin of mandible. Hypostomal carinae rather high behind and rather abruptly reduced at angles, oblique anterior part of each low and but little shorter than longitudinal part. Ocelli a little smaller than in male, the posterior pair a little closer to edge of vertex than to the eyes. Puncturation fine and close on head and thorax, and minute on abdomen. Pubescence dense on face, nearly to level of ocelli, on cheeks, sides of thorax and around margins of mesonotum, and white, except tinged with brown, or brownish ochreous, on vertex and mesonotum. Hypostomal areas and mandibles with fringes of long hairs curving over proboscidial fossa; long hairs also projecting from margin of clypeus and from emargination of inner margin of mandible. Hair of mesoscutum short, appressed, with slightly longer hairs interspaced. Hair of scutellum, especially at sides and apex, and that of metanotum much longer than that elsewhere on thorax. First five metasomal terga each with a broad, dense, white apical hairband; disks of fourth to sixth terga covered with not much thinner appressed whitish hair. Legs densely covered with white hair on outer and posterior surfaces of femora and tibiae. Ventral scopa short and ochreous white. Length, 5.0 to 6.0 mm.; fore wing, 3.5 to 4.0 mm.

Holotype male: Palm Springs, Riverside County, California, on *Cryptantha barbigera,* March 21, 1932 (P. H. Timberlake). Allotype female from the same locality and flower, March 30, 1945 (P. H. Timberlake). Thirty-four female and eight male paratypes from the same locality and flower, March 21 and 26, 1932, March 24, 1933, and March 30, 1945; nine female and one male paratypes

from the same locality, April 16, 1939 (R. M. Bohart); one male paratype, Indio, California, March 25, 1937 (R. M. and G. E. Bohart); two female and six male paratypes, Andreas Canyon, Palm Springs, Riverside County, California, April 7, 1940 (M. R. and R. M. Bohart); two male and one female paratypes, San Felipe Creek, Imperial County, California, April 8, 1939 (R. M. Bohart); one female paratype, four miles east of Edom, California, April 17, 1937 (T. D. A. Cockerell); two female paratypes, Thousand Palms Canyon, California, on *Cryptantha angustifolia*, April 10, 1937 (P. H. Timberlake, G. C. Varley); one male and one female, same locality, March 9, 1940 (R. M. Bohart); and one female paratype, nineteen miles west of Kane Springs, California, on *Cryptantha angustifolia*, March 25, 1933 (P. H. Timberlake); one male and one female paratype, Borego, San Diego County, California, April 8, 1939 (R. M. Bohart).

The holotype and allotype are in the collection of the Citrus Experiment Station, Riverside, California.

Proteriades evansi Michener

Proteriades evansi Michener, 1936, Bull. Southern Cal. Acad. Sci., 35: 92.

This species is most closely related to *deserticola* from which it differs in the less extensive red areas, the acute inner mandibular tooth, and the unproduced median apical portion of the clypeus which does not overhang the base of the labrum, among other characters. This species is known only in the female.

Female: Black, large, dorso-lateral areas on first metasomal tergum, sometimes meeting dorsally, smaller lateral areas on second tergum, and sometimes still smaller ones on third red. Posterior margins of terga testaceous. Mandibles largely reddish, most strongly so subapically. Antennal flagellum dark brown above, light brown beneath. Legs brownish black, distal segments of tarsi paler. Tegulae testaceous. Wings dusky, veins and stigma brownish black. Head slightly wider than thorax. Genal areas distinctly wider than eyes seen from side. Distance between posterior ocelli markedly less than distance from one of them to posterior margin of vertex or to eye margin. Inner orbits slightly diverging below. Clypeus low and broad, about three times as broad as long, not bulging, depressed lateral lobes extending farther downward than any other point, median part of lower margin much thickened and slightly produced to form a very small truncation separated from lateral lobes by broad shallow emarginations. Mandibles thick,

but little narrowed near bases, but with a small, well defined, and deep subapical emargination of inner margin; apical teeth acute. Hypostomal carinae high behind the obtuse angles, low in front of them, the portions in front of angles about as long as those behind. Maxillary palpi three- or four-segmented. Punctation fine, slightly coarser in central part of clypeus than elsewhere on head, slightly coarser on mesepisterna than elsewhere on thorax. Pubescence sparse, forming weak apical bands at sides of first four terga, scattered on fifth and sixth terga. Hypostomal areas with long hairs curved toward mouthparts; clypeus with several long yellowish hairs arising beneath margin of median truncation. Length, 6.6 to 7.6 mm.; fore wing, 4.2 to 4.6 mm.

The type of this species from Loyds, Tulare County, California (August 3), is on deposit at the California Academy of Sciences. Additional specimens are from Coffee Creek, Tulare County, California, on *Cryptantha flaccida*, June 11, 1925 (P. H. Timberlake).

Proteriades semirubra (Cockerell)

Heriades semirubra Cockerell, 1898, Trans. Amer. Ent. Soc., 25: 198; Cockerell, 1903, Psyche, 10: 76; Cresson, 1928, Mem. Amer. Ent. Soc., 5: 71.
Proteriades semirubra, Titus, 1904, Jour. New York Ent. Soc., 12: 25.
Eriades semiruber, Friese, 1911, Das Tierreich, 28: 29.

This species may be immediately recognized in the female by the two long fingerlike processes projecting downward from the clypeal margin. The male is far less distinctive, but can be recognized by the small median prominence of the clypeal margin (a feature shared with *deserticola*, which has the apex of the male abdomen bidentate).

Male: Black, first three metasomal terga red, the basal concavity of the first infuscated, the third frequently and the second occasionally infuscated middorsally; fourth and sometimes fifth terga red laterally; sterna largely red. Mandibles red subapically. Flagellum and tarsi brownish. Tegulae amber colored. Wings dusky hyaline, the veins and stigma dark brown. Head broader than long, as broad as thorax, genal areas about two thirds as broad as eyes seen from side. Distance between posterior ocelli slightly less than distance from one of them to eye margin or to posterior edge of vertex. Inner orbits of eyes subparallel. Antennae long, all flagellar segments longer than broad. Clypeal truncation broader than width of labrum, demarked by distinct angles, gently concave with margin impunctate and thickened, produced to an acute angle just mesad of each end of truncation and to a blunt median angle. Mandibular teeth acute, outer one somewhat longer than inner.

Maxillary palpi rather elongate, four segmented. Middle coxae not toothed; posterior coxae not lamellate. Sixth metasomal tergum with a small but distinct angle on each side, seventh with lateral margins not emarginate, each produced to ventral subapical angle, posterior margin with broad emargination. First metastomal sternum thickened subapically and with dense white pubescence on the posterior declivity of this thickening. Second sternum with strong continuous transverse convexity. Second to fifth sterna with long apical fringes, those of third to fifth conforming to the broad emarginations of the sternal margins. Sixth sternum with the usual ferruginous median fold, the summit of which is flattened nearly to the apex and bears short hairs. Head and thorax very finely punctured, the scutellum and mesepisterna conspicuously more coarsely so than head and mesoscutum. Abdomen minutely and closely punctured. Pubescence white, that of face above clypeus, vertex, and dorsum of thorax ochraceous, that of clypeus exceedingly dense. Pubescence of abdomen short, forming apical white bands at sides of first four metasomal terga, but these bands apparently easily worn off. Length, 5.8 to 7.5 mm.; fore wing, 4.2 to 4.8 mm.

Female: Similar to male in color and sculpture. Black, first three metasomal terga red (darker than in male), except a medial basal patch on each segment, that on the third usually very large. Mandibles variably red at apices and on inner margins. Flagellum strongly reddened beneath, and small joints of tarsi sometimes ferruginous. Tegulae amber color. Wings dusky, with blackish stigma and nervures. Head large and massive, usually much wider than thorax. Genal areas broader than width of eyes and rounded behind. Distance between posterior ocelli much less than distance from one of them to nearest eye margin or to posterior margin of vertex. Clypeus convex, much produced over base of labrum. Anterior margin of clypeus with a small rounded lobe far to each side and in the middle a large projecting lobe provided with a fingerlike process on each side, between which the margin comes to an acute point, the fingerlike processes being strongly divergent. Mandibles large, with the apical two thirds of each quadrate, with nearly parallel inner and outer margins, this portion being about one and one fourth times longer than wide. Inner margin of mandible deeply excavated near base, as is also the exterior surface as far outward as the inner mandibular carina, this excavation making room for the rounded lateral lobes of the clypeal margin, when the mandibles are closed. Mandibular teeth equal, acute. Antennae much shorter than in

male, the flagellum cylindrical, thinner than the scape and about twice as long. Hypostomal carina well elevated, behind the angle, low in front of it, the part anterior to the obtuse angle very oblique, the two parts being nearly equal in length. Almost entire surface with fine, very close punctures, but, as in male, the large basal area of propodeum is smooth and sculptureless except for a finely roughened strip across the base. Pubescence whitish, moderately dense on face, nearly to level of ocelli, and often tinged with brown in fresh specimens on vertex and notum of thorax. First five metasomal terga each with a dense white apical hair-band, more or less thin or interrupted in the middle on first two terga. Disks of last two segments rather densely covered with appressed whitish hair, and disk of preceding segments with short erect hair. Length, 5.8 to 8.5 mm.; fore wing, 3.8 to 5.0 mm.

Cockerell's two type specimens of *semirubra* were from southern California, and Titus had a male from Los Angeles County collected by Coquillett. This probably is the commonest species of the genus in southern California, although at higher elevations it is replaced in this respect by *jacintana* and on the deserts by *xerophila* and *deserticola*. At Riverside the senior author has taken males from March 22 to May 18 and females from April 4 to June 7. It frequents spots only where *Cryptantha intermedia* is growing, and the female obtains its pollen exclusively from the flowers of this plant.

Additional locality records (all in California) are Perris; the Gavilan, Riverside County; six miles east of Temecula, Riverside County; Warner's Hot Springs, San Diego County; Verdemont, San Bernardino County; Mill Creek, San Bernardino Mountains (all collected by P. H. Timberlake). Redlands, San Bernardino County; Andreas Canyon, near Palm Springs; San Jacinto River, San Jacinto Mountains, 4,000 feet altitude; Newhall, Los Angeles County; Coalinga; Jamesburg, Santa Lucia Mountains, Monterey County (all collected by C. D. Michener). Pinacles National Monument, San Benito County (P. D. Hurd). Atascadero, San Luis Obispo County (E. C. Van Dyke). All specimens were collected within the range of dates indicated for Riverside, except that in Monterey County males were collected as late as June 4 and females as late as June 8. All specimens for which complete flower records exist were on *Cryptantha intermedia;* some labeled merely "*Cryptantha*" may have been taken on other species of the genus. A total of over 200 specimens of this species have been examined.

The lectotype male is in the collection of the Academy of Natural

Sciences of Philadelphia. A neallotype female, here designated, is from Redlands, California, May 15, 1936 (C. D. Michener), in the Snow Entomological Collections.

Proteriades jacintana (Cockerell) new combination

Chelostoma (Cephalapis) jacintana Cockerell, 1910, Ann. Mag. Nat. Hist., (8) 5: 23.
Cephalapis jacintana Cockerell, 1925, Proc. California Acad. Sci., (4) 14: 206.

This species is very easily recognized by its elongate form, broad genal areas, the keeled clypeus, the large and virtually tridentate male mandibles, and the long and nearly straight margin between the upper two teeth of the female mandibles.

Male: Black, the first two to four (usually three) metasomal terga red at sides, the red of the first tergum most extensive and often forming a band across the posterior margin of this tergum; first six terga with posterior margins brownish. Mandibles rufescent subapically. Under surface of antennal flagellum often dark brown. Tegulae amber colored. Wings slightly dusky, veins and stigma brownish black. Genal areas as wide as eyes seen from side. Distance between posterior ocelli slightly less than or subequal to distance from one of them to eye margin, much less than distance to posterior margin of vertex. Inner orbits of eyes parallel above, diverging below. Antennal flagellum with middle segments longer than broad. Mandibles large, curved, apices tridentate, outer tooth much longer than next, outer two both acute, inner tooth widely separated from outer two, right angular. Clypeus thickened, with a longitudinal median keel the lower end of which ends at a slight median projection of the produced truncation; truncation thickened, much overhanging base of labrum, short and demarked laterally by angles of about 90°. Maxillary palpi four-segmented. Hypostomal carinae strongly elevated posteriorly. Middle coxae each with a distinct ventral tooth in front of base of trochanter. Posterior coxae each with carina elevated so that it might be considered a low lamella. Sixth abdominal tergum with a rounded angle at each side. Seventh tergum deeply emarginate at apex, the resulting lobes longer than wide, blunt, each about as broad as space between them. First metasomal sternum somewhat thickened with declivous, hairy, posterior margin. Second sternum large, weakly fringed. Third to fifth sterna well fringed, fringe of third dense in middle, of fifth conforming to broadly emarginate sternal margin. Sixth sternum with the usual ferruginous fold very long and well developed, ending rather abruptly at base, terminating in a short spine, summit of fold broadened and provided with short hairs. Punctation fine and

dense, coarser on mesepisterna than elsewhere on head and thorax. Pubescence rather dense, white, slightly ochraceous on dorsum of head and thorax, dense on face nearly to level of anterior ocellus, forming apical bands on first five metasomal terga. Length, 6.5 to 8.4 mm.; fore wing, 4.5 to 5.2 mm.

Female: Coloration similar to male, but red confined to first two metasomal terga and not extending as a band across posterior margin of first. Genal areas much broader than eyes seen from side. Distance between posterior ocelli less than distance from one of them to eye margin, much less than distance from one of them to posterior margin of vertex. Inner orbits diverging below. Clypeus with a carinate longitudinal median keel; truncation much overhanging base of labrum, much shorter than distance from end of truncation to lateral angle of clypeus; sublateral angle weak and midway between end of truncation and lateral angle of clypeus. Mandibles large, narrowed near bases by emarginations of upper and lower margins, much expanded apically, middle and inner teeth scarcely acute, widely separated, connected by long and nearly straight margin. Maxillary palpi four-segmented. Hypostomal carinae elevated posteriorly. Carinae of posterior coxae reduced and inconspicuous. Punctation fine and dense, coarser on clypeus than on rest of head. Pubescence sparser on face than in male, forming apical bands on first four terga, scattered, denser apically, on fifth and largely covering sixth. Length, 7.0 to 10.5 mm.; fore wing 4.2 to 5.4 mm.

The male type of this species, from Kenworthy, San Jacinto Mountains, California, is in the collection of the Citrus Experiment Station at Riverside, California. The species is a common one, especially in the southern California mountains and is known from the following localities, all in California: Warner's Hot Springs, San Diego County; Stone Creek, Keen Camp, Idyllwild, San Jacinto River (4,000 feet altitude) two miles southeast of Poppet Flat, Herkey Creek, Vandevanter Flat, Ribbonwood, and Mount Santa Rose (7,500 feet altitude), all in San Jacinto Mountains; Mill Creek (4,400 to 4,700 feet altitude) and Forest Home, both in San Bernardino Mountains; Ortega Highway, Santa Ana Mountains, overlooking Elsinore; Riverside; Claremont; Eagle Rock, Los Angeles County; Newhall, Los Angeles County; Pinacles, San Benito County; Jamesburg, Santa Lucia Mountains, Monterey County (1,900-2,700 feet altitude); Yosemite (3,880-4,000 feet altitude); Midway; Madera County (3,000 feet altitude); Coffee

Creek and Carrville (2,400-2,500 feet altitude), Trinity County; Big Pine Creek, Inyo County (7,500 feet altitude); Rock Creek, Mono County (8,500 feet altitude). The flower visited in southern California is usually *Cryptantha intermedia* but it has also been collected on *C. micrantha* var. *lepida*. Flower records for the more northern collections are merely *Cryptantha* sp.? Dates of collection for males range from April 20 to June 23, for females from April 20 to July 5.

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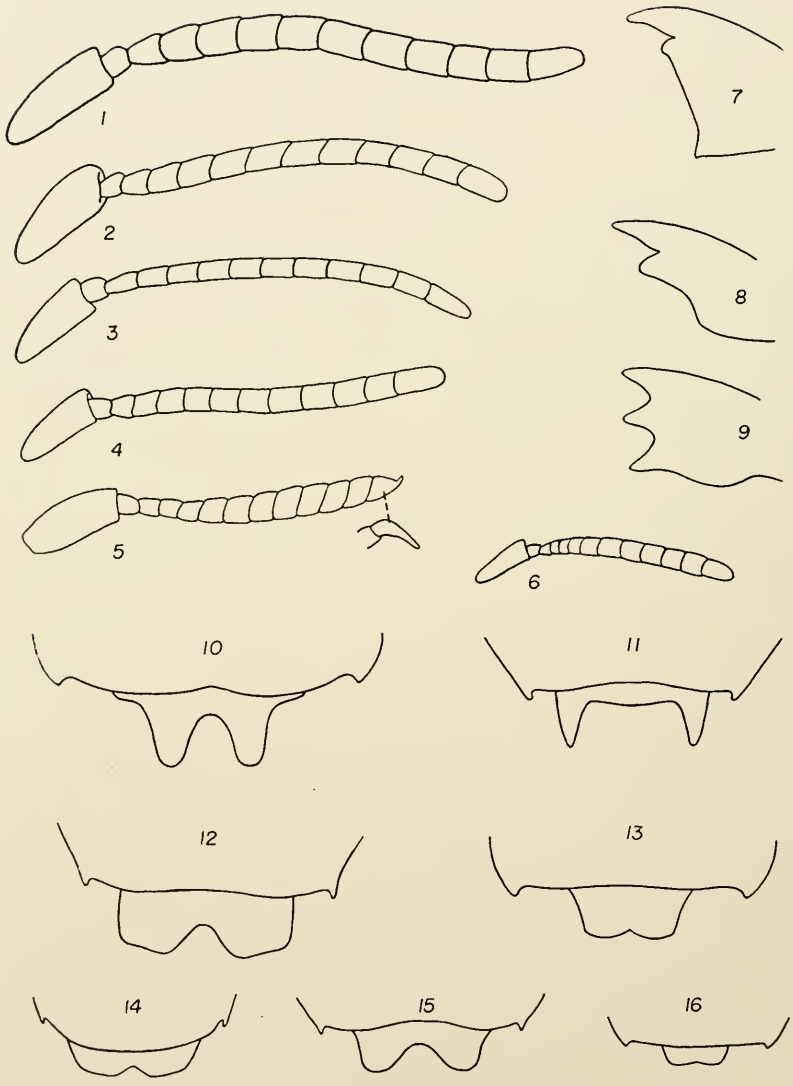
1944a The distribution of the osmiine bees of the deserts of North America, Amer. Nat., 78: 257-266.

PLATE III



1-6, Antennae of males, 1, *P. semirubra;* 2, *P. boharti;* 3, *P. caudex;* 4, *P. bidenticauda;* 5, *P. hamulicornis;* 6, *P. pygmaea.* 7-9, Apical portions of mandibles. 7, *P. jacintana,* female; 8, *P. jacintana,* male; 9, *P. semirubra,* female. 10-16, Sixth and seventh metasomal terga of male. 10, *P. jacintana;* 11, *P. bidenticauda;* 12, *P. semirubra;* 13, *P. hamulicornis;* 14, *P. boharti;* 15, *P. caudex;* 16, *P. pygmaea.*

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Second Contribution to the Herpetology of San Luis Potosí

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ABSTRACT: A report is made on a small herpetological collection from the Mexican State, San Luis Potosí. One new species, *Adelphicos newmanorum*, is described, and the known ranges of several species are extended to the State.

In a recent issue of this journal,* thanks to the kindness of Prof. George H. Lowery of Louisiana State University, I reported on a large herpetological collection made in the state of San Luis Potosí, Mexico, by a collecting party from the Louisiana State University, consisting of Mr. and Mrs. Robert Newman and Mr. Charles Shaw. The bulk of the collection, however, was acquired by Mrs. Newman. Most of the specimens were taken in the region of Xilitla, in the southeastern portion of the state; a few, however, were obtained in other localities.

One group of specimens from the collection was described by Dr. J. A. Tihen as a new subspecies, *Gerrhonotus leiocephalus loweryi*.†

On July 2, 1948, a second collection was forwarded to me from Louisiana State University. This material was likewise acquired in San Luis Potosí, largely in the Xilitla region, by a collecting party consisting of Mr. and Mrs. Robert Newman, Mr. Herbert Stern, Mr. Prentiss D. Lewis, and Mr. George Lowery. The material, while not so extensive as the preceding collection, does contain material of importance, including certain new state records. One of these is a very rare Mexican rattlesnake, *Crotalus basiliscus totonacus*.

* Univ. Kansas Sci. Bull., vol. 33, pt. 1, pp. 169-215.

† Trans. Kansas Acad. Sci., vol. 51, 1948, pp. 302-305.

Altogether there are 55 specimens representing 23 species. I am again obligated to Professor Lowery for the privilege of examining this second collection.

The following species, one of which is described as new, are here recorded from San Luis Potosí for the first time:

Adelphicos newmanorum sp. nov.
Thamnophis subcarinatus subcarinatus (Gray)
Drymobius chloroticus (Cope)
Micrurus fulvius tenere (Baird and Girard)
Crotalus basiliscus totonacus Gloyd and Kauffeld.

The entire known herpetological fauna of San Luis Potosí totals 140 species. This is divided as follows: salamanders, 5; Salientia, 25; lizards, 33; snakes, 78; turtles, 3.

The map showing collecting localities in San Luis Potosí, as well as the data on the localities included in the text, has been prepared by Dr. George H. Lowery to whom I offer my sincere thanks.

AMPHIBIANS

Bufo valliceps Wiegmann

A single specimen having the typical light coloration is in the collection.

Smilisca baudinii Duméril and Bibron

A single medium-sized female specimen was taken.

LIZARDS

Sceloporus variabilis variabilis Wiegmann

A series of eight specimens was taken at Hda. Limón, 10 mi. W of Ébano, San Luis Potosí between March 30 and April 24, 1948.

Sceloporus serrifer plioporus Smith

A single specimen was taken at Hda. Limón, 10 mi. W. of Ébano. The femoral pores are 20; the dorsal scales, 31. The color, and much of the pattern, has disappeared due to preservation.

Sceloporus grammicus disparilis Stejneger

A single specimen taken on the Llano de Coneja at 7,000 ft., is referred to this subspecies. The dorsal scales number 70 from occiput to a line joining the posterior surface of the thighs. This locality is near the area of intergradation between *g. disparilis* and *g. microlepidotus*.

Corythophanes hernandesii (Gray)

Seven specimens, Nos. 615 to 621, are in the collection, all from the Xilitla region. These were obtained by Marcella Newman.

Gerrhonotus leiocephalus loweryi Tihen

Three topotypic specimens from Xilitla are in the collection. Two (Nos. 612 and 614) have the granular area in the lateral fold definitely marked with vertical dark lines. The smallest specimen (No. 613) shows no such markings. Otherwise they agree in significant characters.

Ameiva undulata podarga Smith

Five specimens (Nos. 623-627) are in the collection, four from Xilitla and one (No. 627) from Tamuzunchale.

SNAKES

Ninia diademata plorator Smith

A portion of a badly preserved specimen from Xilitla is included in the collection (No. 609).

Adelphicos newmanorum, sp. nov.

PL. IV

Holotype: Louisiana State University No. 204, ♂, Xilitla region, San Luis Potosí, May 7, 1947; Marcella Newman, collector.

Diagnosis: A species of average size for the genus having the third labial replaced on edge of lower lip by the enlarged first chinshields; no lateral stripes present on the body; venter immaculate white; subcaudal region with a slight median peppering of pigment; above brownish gray, the scales faintly outlined with heavier pigment.

Description of type: Rostral at least one third wider than high, the part visible above triangular, as long as the suture between the internasals; latter scales small, wider than long, their length about one third the length of prefrontals, their area between one fourth and one fifth of the prefrontals; prefrontals as broad as long, entering the orbit; frontal triangular, as long as wide, about one fifth longer than the prefrontal; parietals elongate, about one fifth longer than their distance from the end of the snout, their common suture, however, being about two thirds the length of the frontal; nasal divided, the anterior part less than half the area of the posterior, the nostril pierced between the two parts very close to the rostral; loreal slender, elongate, entering orbit on right side, while on left

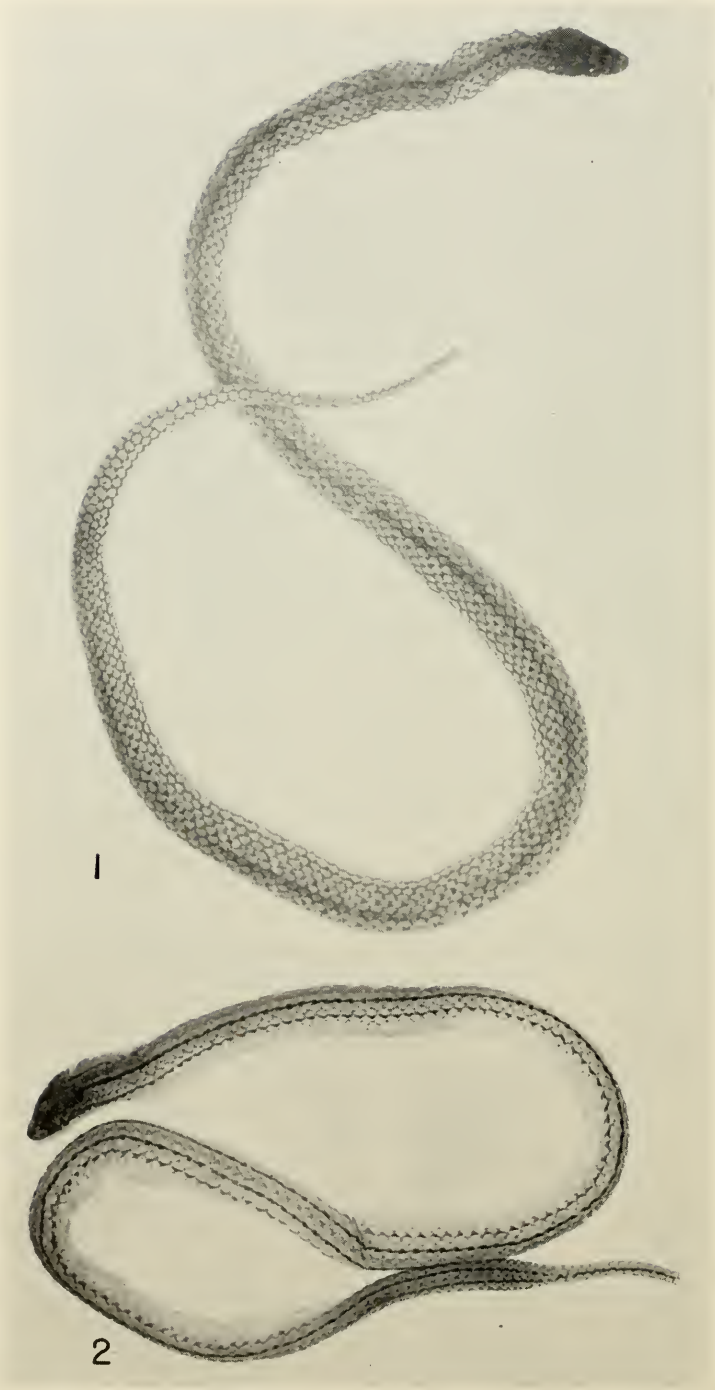


PLATE IV. Fig. 1. *Adelphicos newmanorum* sp. nov. Louisiana State University No. 204, Type. Xilitla region, San Luis Potosí, Mexico (total length, 310 mm.). Fig. 2. *Adelphicos quadrivirgatus quadrivirgatus* Jan. Louisiana State University No. 206. Xilitla, San Luis Potosí, Mexico (total length, approx. 360 mm.).

side, shorter, triangular, excluded from eye by contact of third labial and prefrontal; no preocular; two postoculars, the upper double size of lower; temporals large, one behind the other, the posterior as large or slightly larger than anterior.

Supralabials, 7-6, in the following ascending order of size: left—1, 2, 3, 6, 4, 5, 7, the third and fourth entering the orbit; on right side the second and third are fused, and only the fourth enters the the orbit; infralabials presumably 6, the third being replaced by the much widened first chinshield, first pair of chinshields followed by an azygous pregular; second pair of chinshields not or scarcely differentiated, and separated by a second median gular a little larger than the first. Diameter of eye about 2½ times in length of snout.

Scale formula: 15-15-15; ventrals, 139; caudals, 49; anal divided; total length, 310 mm.; tail 61 mm.; head length, 7.5 mm.; head width, 5.9 mm.

Color in formalin: Above light grayish brown, the edges of all scales somewhat more heavily pigmented than centers; a very faint median grayish line; venter and outer scale row white; second scale row light but with some scattered pigment; an indistinct gray subcaudal line; head dark reddish brown; labials, save for their upper edges, cream.

Relationship: This form is related to *quadrivirgatus quadrivirgatus* (Pl. IV, fig. 2) in having the anterior chinshield form a part of the labial border and in having the chinshield followed by two median gulars, one following the other, separating the poorly differentiated second pair of chinshields.

The head, however, is somewhat more slender than in that species, the frontal being longer than its distance from the tip of the snout (in *quadrivirgatus* less than this same distance). The top of the head is more reddish brown, and the labials are somewhat lower. The typical quadrilinear markings of *q. quadrivittatus* are lacking.

Remarks: On one side the lower jaw, and an area on the neck has been injured by ants.

Bocourt* has described a slender-headed variety of *Adelphicos quadrivirgatum* as *acutirostrum* (type locality, "Mexique"). His form was striped. The subcaudal count was 32, the ventrals, 135. Smith and Taylor (Bull. 187, U. S. Nat. Mus., p. 30) regard this form as a synonym of *Adelphicos q. quadrivirgatus* Jan.

* Mission Scientifique au Mexique . . ., Études sur les Reptiles, livr. 9, 1883, pl. 32, figs. 11b, 11c, 12b, 12c.

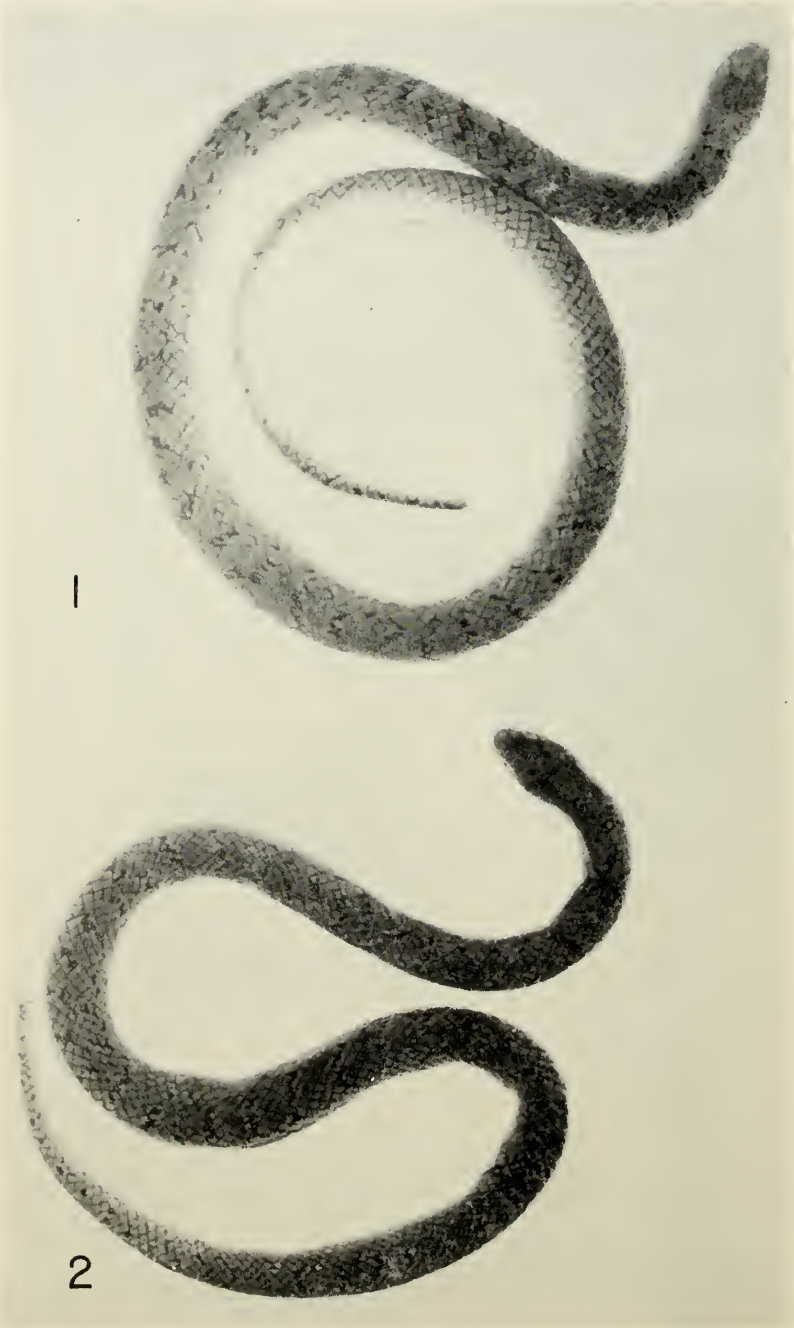


PLATE V. Fig. 1. *Ficimia streckeri* Taylor; Louisiana State University No. 214 ♂, Xilitla, San Luis Potosí, Mexico (total length, 426 mm.). Fig. 2. *Ficimia streckeri;* Louisiana State University No 208 ♂, Xilitla, San Luis Potosí, Mexico (total length, 383 mm.).

PLATE VI. Fig. 1. *Rhadinaea forbesi* Smith; paratype. Fig. 2. *Rhadinaea marcellae* Taylor. Louisiana State University No. 270. Type, Xilitla region, San Luis Potosí, Mexico (total length, 290 mm.).

Ficimia streckeri Taylor

Pl. V, figs. 1 and 2

Three specimens in the collection from Xilitla, Nos. 605 ♂, 606 ♂, and 607 ♀, respectively, yield the following scale data: postoculars, 2-1, 2-2, 1-1; scale formulae, 19-17-17, 19-17-17, 19-17-17 (the number 19 occurs only on the anterior part of the neck); ventrals 156, 153, 142; caudals, 34, 34, 33; totals, 190, 186, 175. Most of the scales on the anterior part of the body in the two younger specimens have single median terminal pits instead of the typical pair. In the older specimen, No. 607, however, the pits are scarcely discernible. If the epidermis has been shed they cannot be seen.

The narrow bars, present in Nos. 606 and 607, to the number of 41 and 43 respectively, are, in No. 605, replaced by a median series of spots, two or two and one half scales long and about as wide. There are but thirty such marks. On the sides are two rows of elongate spots below which are some smaller indefinite spots reaching the ventrals.

Rhadinaea marcellae Taylor

Pl. VI, fig. 2

Rhadinaea marcellae Taylor, Univ. Kansas. Sci. Bull., vol. 33, pt. 1, 1949, pp. 197-198.

The type specimen of this species is figured. A figure of *Rhadinaea forbesi* Smith is also included for comparison. (Pl. VI, fig. 1.)

Rhadinaea crassa Smith

Three specimens, Nos. 601-603, of this species, two from Xilitla, and one from Cueva Salitre, near Xilitla, are in the collection. The tails of Nos. 601 and 603 are broken, while the body of No. 602 is badly crushed.

Elaphe flavirufa flavirufa (Cope)

A very large male specimen, No. 585, was collected at Hda. Limón, 10 mi. W of Ébano, San Luis Potosí, by Prentiss D. Lewis. The specimen measures 1525 mm. in total length, the tail 286 mm.

This specimen differs from younger specimens in having scattered ventral black flecks (of a size equal to the surface area of one or two dorsal scales) that grow more numerous on the posterior part of the body, so that the dark color rather than the light is predominant. The subcaudals are dark over most of their surface, only a small anterior portion of each being white.

There are 34 dorsal body spots and 15 caudal spots; the ventrals are 247; anal divided; caudals, 106.

PLATE VII. *Pliocercus laticollaris* Smith, Louisiana State University No. 559. Xilitla, San Luis Potosí, Mexico (total length, 541 mm.).

Pliocercus laticollaris Smith

PL. VII

A specimen of this species was reported from Xilitla in my first paper on the San Luis Potosí fauna. A figure based on a photograph of the preserved specimen is included here.

Drymobius chlorot'cus (Cope)

Dendrophidium chloroticum Cope, Proc. Amer. Phil. Soc., vol. 23, 1886, p. 278.
Drymobius chloroticus Cope, U. S. Nat. Mus. Bull., no 32, 1887, p. 69.

This species, with a type locality at Cobán, Guatemala, has heretofore been reported in Mexico only in southern Veracruz and in Chiapas. The collection contains one specimen, No. 591, young ♀, collected at Xilitla, San Luis Potosí, by Mr. Herbert Stern, Jr. This is the most northern record, extending the known range about 280 miles to the northwest.

The ventrals are 164; anal divided; subcaudals, 116 + 1.

The original green coloration has disappeared and a dim pattern of transverse darker marks, narrowly edged with white, is evident; the whitish edges of the bands are separated by three scales. Anteriorly, the skin between the scales is light. The head is black but most of the rostral and the supralabials are cream except on their upper edges. The infralabials and chin are cream white. The coloration of the sides extends onto the ventrals. There are 38 maxillary teeth, the posterior approximately a half larger than anterior. The scale formula is 17-17-15, the eleven middle scale rows with keels.

Drymobius margaritiferus margaritiferus (Schlegel)

A single specimen, No. 587, was collected at Hda. Limón, ten mi. W of Ébano.

Dryadophis melanolomus veraecrucis Stuart

Six specimens, Nos. 593-598, are in the collection; two are from Apetsco, four from Xilitla. A young specimen, No. 598, has the body uniform dark brown. A white line beginning on the labials below the eye can be traced along the side of the neck and body where it appears so dim that it can scarcely be traced. I cannot discern any transverse markings in this specimen.

Spilotes pullatus mexicanus (Laurenti)

A young specimen, No. 586, is in the collection from Xilitla. The head has the reduced pattern of black. The dark bars on the body, after the first eleven, are nearly transverse losing the strong diagonal

trend of the anterior bars. There are 21 bars on the body posterior to the nuchal band, and 12 caudal bands. Ventrals, 200; anal single; caudals 118 + 1.

Lampropeltis triangulum polyzona Cope

Two female specimens, one from Apetsco, Xilitla Region (No. 588), and one from Xilitla (No. 589), are referred to this subspecies. One of the specimens has the black bands widened dorsally so that in many cases the bands are separated on the middorsal line by a single row of red scales. This specimen might be regarded as an intergrade with the subspecies *arcifera* known also from the Xilitla region. In this specimen the red scales are shaded with dark pigment but there are no distinct black spots.

No. 588 from Apetsco is a typical *polyzona*, the red interspaces being as wide as the black bars. Each red scale has a discrete black spot.

The ventral and subcaudal counts for Nos. 588 and 589 respectively are: 211, 216, 46 + 1, 49 + 1.

Leptodeira annulata septentrionalis (Kennicott)

This species is represented by a single specimen (No. 592) from Xilitla, taken April 25 by Marcella Newman.

The specimen yields the following scale data: Preoculars, 3-3, the upper touching the frontal on each side; postoculars, 2-2; supralabials, 8-8; infralabials, 10-10; temporals, 1 + 2; scale formula 21-23-23-17; ventrals, 195; caudals, 73; anal divided. Thirty bands on body; 16+ on tail.

The minute grayish pigment flecks on the venter are fewer than those usually present. The bands are a little narrower than those on specimens from farther north.

Thamnophis subcarinatus subcarinatus (Gray)

Coluber (*Natrix*) *subcarinata* Gray, Zoology of Beechey's Voyage, 1839, p. 96, pl. 32 (type locality "the hedges of Xalisco" Mexico.)

Thamnophis subcarinata subcarinata Smith, Herpetologica, 1949, vol. 5, pp. 63-64. (Type locality restricted to Guadalajara, Jalisco.)

This species is represented by a male specimen (No. 590) collected at Laguna de las Rusias, Villa de Reyes region, San Luis Potosí. The ventrals are 163, the caudals 64 + 1.

The reduced caudals in the male separates this subspecies from *subcarinatus megalops* that has 79 or more subcaudals. The latter, a more western subspecies, has also been found within the limits of the state.

Storeria dekayi texana Trapido

A specimen from Xilitla (No. 608), with 17 scale rows in the middle of the body, two pairs of chinshields present, lacking both a loreal and a horizontal dark mark on the anterior temporal, is referred to this species. The ventrals in this specimen are 139; anal divided; and caudals 55. The scale formula is 17-17-17.

PLATE VIII. *Micrurus fulvius tenere* (Baird and Girard.) Louisiana State University No. 310. Ébano, San Luis Potosí, Mexico (total length, 703 mm.).

The dorsal coloration in preservative is nearly uniform brownish gray with some few small blackish spots anteriorly. The venter is lighter with two or more black dots on the end of each ventral. On the underside of the tail the caudals are edged with gray and are without dots.

Micrurus fulvius tenere (Baird and Girard)

Pl. VIII

This species is represented by a single specimen, L.S.U. No. 310. I originally reluctantly referred* this specimen to *Micrurus fitzingeri microgalbineus* Brown and Smith. I pointed out the characteristics by which the specimen differed from typical *M. f. microgalbineus*, and gave scale data. The colors are badly faded. A figure of the specimen is included.

Micrurus fitzingeri microgalbineus Brown and Smith

Pl. IX

A figure of L.S.U. No. 308, Xilitla, San Luis Potosí, is given.

Crotalus basiliscus totonacus Gloyd and Kauffeld

Crotalus totonacus Gloyd and Kauffeld, Bull. Chicago Acad. Sci., vol. 6, no. 2, p. 12, fig. 1-2 (type, Chicago Academy of Science no. 4469, Panaco Island [about 75 mi. S of Tampico], Veracruz, 12 mi. inland from Cabo Rojo).

Since only one specimen besides the type and paratype of this species is known, and only the type has a definite locality, it is with very considerable interest that I report the discovery of this rare species on the mainland of Mexico at Hacienda Limón, 10 mi. W of Ébano, San Luis Potosí. These specimens, Nos. 583 and 584, were collected respectively by Mr. Herbert Stern, Jr., and Mr. Prentiss D. Lewis.

The smaller complete specimen, No. 583, measures 813 mm. in total length, the tail, 68 mm. The rattle is short, being only 16 mm. The head measurements are: width, 26.6 mm.; length, 33 mm. The ventrals are 194, the caudals 26. The anal is single. The nostril is higher than wide, and broadly in contact with the prenasal. A pair of internasals are present, followed by a pair of prefrontals (one prefrontal and one internasal being partially fused). The supraoculars are large, flat, and separated anteriorly by a single frontal that is divided transversely near the middle, and with the posterior portion of the frontal apparently segmented longitudinally. In contact with the posterior frontal and the supraoculars, is a some-

* Univ. Kansas Sci. Bull. vol. 33, pt. 1, 1949, p. 213.

PLATE IX. *Micrurus fitzingeri microgalbineus* Brown and Smith, Louisiana State University No. 308, Xilitla, San Luis Potosí, Mexico.

what enlarged parietal separated from its fellow by a pair of scales. The supralabials are 12-12, the infralabials 13-13. The nostril is represented by a vertical slit between the nasals and the second nasal is followed by a pair of superimposed loreals. Two large preoculars follow these scales, both entering the orbit. A series of four

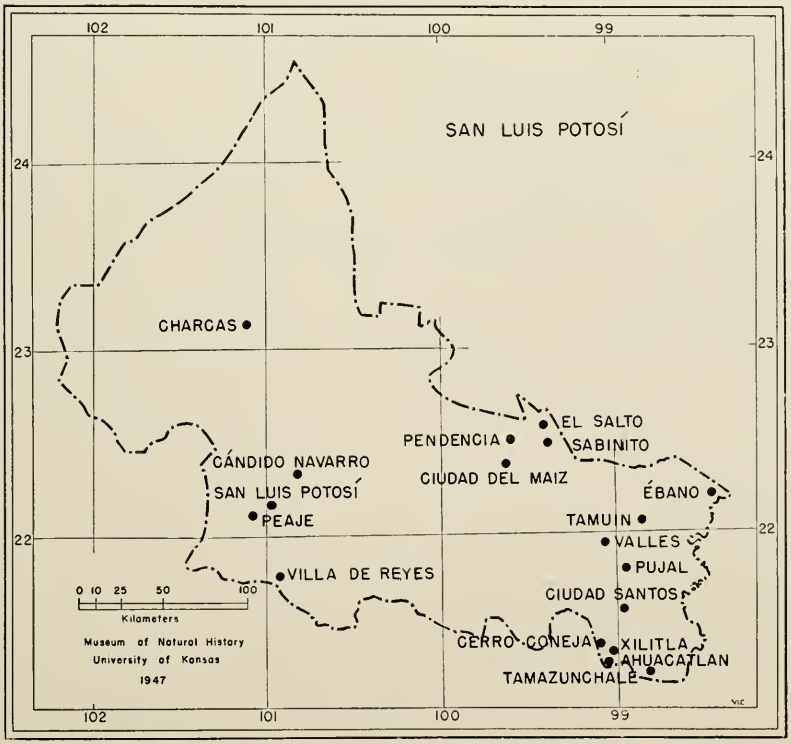
diminutive scales are present anterior to the large scale bordering the pit. The pit is surrounded by four scales, including the lower preocular. The two lower scales are in contact with the labials. There are two or three scale rows between the labials and the eye. The three lower rows of temporals are unkeeled, the upper rows slightly keeled. Three labials touch the anterior chinshields.

The color pattern of this specimen resembles closely the figure of the type given by Gloyd (1940), even to the smaller detail of the head pattern.

The second specimen is a large male, but the head, with a portion of the neck, is missing. The preserved portion measures 1360 mm. of which tail and rattle measure 150 mm., the rattle alone, 35 mm. The scale formula is 25-25-23-21.

Bothrops atrox asper (Garman)

Three specimens of this large species are in the collection (Nos. 599 to 601). Two large specimens are from Xilitla, a small one from Hda. Limón, 10 mi. W of Ébano.



Map showing collecting localities in San Luis Potosí

The three specimens present the following scale data:

Data on *Bothrops atrox asper* (Garman)

No.	*Sex*	*Ventrals*	*Sub-caudals*	*Labials*	*Infra-labials*	*Scale formula*	*Total length*	*Tail length*
599	♂	205	63+1	7-7	10-10	27-29-21-20	1,535	184
600	♂	209	65+1	7-7	11-10	26-25-21-19	1,560	197
601	♀	211	61+1	7-7	10-10	28-26-21-20	1,015	132

LIST OF LOCALITIES

AHUACATLAN: a small village at 3,800 feet situated among mountains rising to over 5,000 feet.

APETSCO: a locality approximately 1.5 miles NW of Xilitla; elevation *ca.* 2,600 feet.

AXTLA FERRY ON ROAD TO XILITLA: a ferry crossing on that part of the Río Axtla locally known as the Río Huichihuayan; elevation *ca.* 300 feet.

CÁNDIDO NAVARRO: a village on Ciudad San Luis Potosí-Antiguo Morelos Highway approximately 15 miles northeast of the city of San Luis Potosí.

CERRO CONEJA: the highest measured peak in the Sierra Madre Oriental proper of San Luis Potosí; elevation 8,699 feet. Specimens with this locality designation were taken at elevations ranging between 6,200 and 7,400 feet.

CIUDAD DEL MAIZ: a town on Ciudad San Luis Potosí-Antiguo Morelos Highway; elevation 4,000 feet.

CIUDAD SANTOS: current name for village formerly known as Tancanhuitz; elevation 770 feet.

CHARCAS: a town 68 miles north of Ciudad San Luis Potosí; elevation 6,580 feet.

CUEVA SALITRE: a cave located on the outskirts of village of Xilitla.

ÉBANO: a town near estern border of state; elevation *ca.* 100 feet.

EL SALTO: a waterfall about 5 miles N of Ciudad del Maiz-Antiguo Morelos Highway; elevation 2,000 feet. Specimens were taken at an elevation of about 1,500 feet. This is Salto del Agua of some maps.

HACIENDA LIMÓN: a general collecting site about 10 miles W of Ébano; elevation 45 feet.

JOYA DE LA SILLETA: a locality adjacent to Llano de Garzas; elevation *ca.* 6,200 feet. The spelling of this place name was erroneously transliterated in the early stages of the field work as "Joya de Asietta."

LAGUNA DE LAS RUSIAS: an artificially empounded body of water, with dense stands of rushes and other aquatics, located 3 miles SW of Villa de Reyes; elevation 6,000 feet.

LLANO DE GARZAS: one of several mountain meadows in neighborhood of Cerro Coneja; elevation *ca.* 6,800 feet.

LLANO DE CONEJA: a mountain meadow in neighborhood of Cerro Coneja; elevation *ca.* 7,000 feet.

MIRAMAR: this locality designation refers to Cerro Miramar, a mountain overlooking the village of Xilitla; elevation *ca.* 4,500 feet.

PEAJE: a village approximately 8 miles SW of the city of San Luis Potosí on highway to Guadalajara; elevation *ca.* 6,400 feet.

PENDENCIA: a village 2.5 miles N of San Luis Potosí-Antiguo Morelos Highway; elevation *ca.* 4,500 feet.

PRESA DE GUADALUPE: a village on Ciudad San Luis Potosí-Antiguo Morelos Highway; elevation *ca.* 4,000 feet.

PUERTO DE LOBOS: a point on Ciudad San Luis Potosí-Antiguo Morelos Highway 2.5 miles S of Pendencia; elevation 4,300 feet.

PUJAL: a town on Pan-American Highway; elevation *ca.* 300 feet.

RANCHO MIRAMAR GRANDE: a locality about halfway along trail between Cerro Miramar and Cerro Coneja, including collecting points from 4,500 to 5,000 feet.

SABINITO: a village on Ciudad del Maiz-Antiguo Morelos Highway; elevation 1,300 feet.

SAN LUIS POTOSÍ RESERVOIR: an impounded body of water on the southwestern outskirts of the city of San Luis Potosí; elevation 6,300 feet.

TAMAZUNCHALE: a town on Pan-American Highway in the southeastern part of the State; elevation *ca.* 400 feet.

TAMUIN: the present name for a village formerly known as Guerrero, located on Valles-Tampico Highway; elevation 150 feet.

VALLES: a town on Pan-American Highway; elevation 250 feet.

VILLA DE REYES: a town 25 miles S of the city of San Luis Potosí; elevation 6,000 feet.

UPPER LLANO DE CONEJA: a meadow on shoulder of Cerro Coneja; elevation 7,200 feet.

XILITLA: a town in southeastern part of State, 14 miles by road west of Pan-American Highway; elevation *ca.* 2,200 feet.

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On the Status of the Family Desmognathidae (Amphibia, Caudata)

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ABSTRACT: The anatomical features of the salamanders of the genera *Desmognathus* and *Leurogmathus* are re-examined. Especial study of the characteristics of the vertebrae is made. The author concludes that the vertebrae differ basically from those of the family Plethodontidae and that this fact, together with numerous other anatomical differences, warrants the re-establishment of the family Desmognathidae. He includes the genera *Leurognathus* and *Desmognathus*.

INTRODUCTION

The genus *Desmognathus* comprises a group of common North American salamanders, which occur from the southern extreme of New Brunswick southward to northern Florida and southwestward to the eastern extremes of Texas and Oklahoma. There are at present eleven species and subspecies recognized in this genus. The anatomy, physiology, and life history of the animals of this group have been extensively investigated and are well known. The ready availability of these animals where they occur makes them ideal for such investigations. Mrs. I. W. Wilder (1913) published a complete work on the life history of *Desmognathus fuscus*. Seelye (1906) investigated the circulatory and respiratory systems of this species. Fish (1895) published a detailed account of the nervous system and its development in the same species. Other authors also have reported upon their investigations of this and other forms of *Desmognathus*. The ecology of the various species of this genus has also been detailed at various times chiefly by G. K. Noble, E.

R. Dunn, C. H. Pope, and C. S. Brimley. A considerable literature has appeared on the taxonomy of the salamanders of the genus Desmognathus.

In contrast to the general agreement among workers upon the anatomy, physiology, and life histories of the members of this genus, the taxonomic literature indicates a marked disagreement as to the higher taxonomic categories. Baird (1849) used this name to denote a genus that then contained only the three known species: *D. fuscus* (Rafinesque), *D. auriculatus* (Holbrook) [= *D. fuscus auriculatus*], and *D. niger* (Green) [= *D. quadramaculatus quadramaculatus*]. In 1866, Cope proposed the family Desmognathidae, with the single genus *Desmognathus*, and in 1869, he published a complete classification of the lungless salamanders proposing another family Thoriidae having a single type genus *Thorius*.

Boulenger in 1882 placed the then recognized families Salamandridae, Amblystomatidae, Plethodontidae, and Desmognathidae together in a single family Salamandridae. He arranged each of the former families as subfamilies and placed the genus *Thorius* in the subfamily Desmognathinae.

Cope again in 1889, in his "Batrachia of North America" persists in maintaining family rank for the Desmognathids and the other groups that Boulenger had reduced to subfamily status. Thus a *status quo* was reached, with zoologists adhering either to Boulenger's or Cope's classification.

In 1892 Stejneger described a new genus *Typhlotriton* ascribing it to the family Desmognathidae following Cope's classification. In 1893 Cope described a new genus *Haptoglossa* from Costa Rica and revised his concept of the thoriid group reducing it to subfamily rank as Thoriinae under the Desmognathidae and referring to it three genera: *Thorius* Cope, *Typhlotriton* Stejneger, and *Haptoglossa* Cope. Moore in 1899 described *Leurognathus*, a new genus of the family Desmognathidae.

In 1900 Moore, basing his opinion on his own observations and those of Vaillant in 1882 and 1886, concluded that the family Desmognathidae was not valid. He based his conclusions solely on the characteristics of the articulation of the vertebrae. He included the desmognathid group in the family Plethodontidae, yet did not exclude the possibility of its classification as a subfamily.

Fowler in 1907 and Hurter and Strecker in 1909 retained the Desmognathidae as a valid family. In 1908 Brown designated *D. fuscus fuscus* (Rafinesque) as the type species of the genus *Desmognathus*

and also retained the family Desmognathidae. In Mrs. Wilder's work "The life history of *Desmognathus fuscus*" in 1913, she considered the genus *Desmognathus* to be a member of the family Desmognathidae. However, in 1912 Brimley placed *Desmognathus* as a genus of the family Plethodontidae, as did Fowler and Dunn in 1917. Nevertheless Dunn in the same year treated the genera *Desmognathus* and *Leurognathus* as members of the plethodontid subfamily Dismognathinae (*sic*).

In 1917 Stejneger and Barbour considered *Desmognathus* under the family Plethodontidae. Finally in 1926 Dunn placed *Desmognathus* under the Plethodontidae, but did not mention his previous subfamily Dismognathinae. Although he suggested some form of generic grouping of the plethodonts, he made no attempt at actual taxonomic differentiation of these generic groups. From 1926 until the present, Dunn's classification has been generally used. However, Taylor (1944: 193 and 204) questioned Moore's reasons for invalidating the Desmognathidae. Very recently Smith and Taylor (1948) have come to recognize the Desmognathidae as a valid family.

Since it has been shown that there are still uncertainties and differences of opinion as to the higher taxonomic categories of this group, it has become apparent that a re-examination of the problem is absolutely necessary. Consequently I have re-examined such material as is listed below and I have noted similarities and differences among these groups, especially as regards the Plethodontidae. I have tried to weigh carefully their relative importance, and on this basis award this group of salamanders the taxonomic rank which it seems to deserve. The following points are considered:

1. That the principle of taxonomic differentiation on the basis of vertebral articulations in salamanders is still a concept that must be applied to differentiate between the Desmognathidae and other families.

2. That the family has other differentiating characters besides the vertebral articulations—characters which must be taken into consideration in evaluating the taxonomic rank and relations of this group.

3. That the Desmognathidae is a valid family.

4. That the family Desmognathidae comprises the two genera *Desmognathus* and *Leurognathus*. The possibility of a third genus, *Haptoglossa*, is considered.

MATERIALS AND METHODS

There have been available for study specimens and skeletons of *Desmognathus fuscus fuscus, D. fuscus brimleyorum, D. fuscus auriculatus, D. ochrophaeus ochrophaeus, D. ochrophaeus carolinensis, D. quadramaculatus quadramaculatus, Leurognathus marmorata marmorata, and L. marmorata intermedia.* I have studied material of the following plethodontid genera: *Plethodon, Thorius, Eurycea, Gyrinophilus, Pseudotriton, Ensantina, Chiropterotriton, Hydromantes, Batrachoseps, Hemidactylium, Manculus, Pseudoeurycea, Magnadigita,* and *Bolitoglossa.* I have also studied family characteristics as evidenced by skeletal and preserved material of *Taricha, Diemictylus, Siren, Necturus,* and *Ambystoma.*

The procedure followed was first, to make examination of osteological material of the various species of *Desmognathus* and *Leurognathus.* Then comparisons were made with skeletal structures of the genera previously mentioned. Emphasis was placed on the morphology of the vertebral column and cranial structures although other characters were also observed. Secondly, a comparative study of the musculature of various species of *Desmognathus* and *Leurognathus* were undertaken and again comparisons were made with the other forms. Emphasis here was given chiefly to the muscles of the head and throat.

Owing to limited time a study of the microscopic anatomy of these forms was not feasible. However realizing the possibility that important taxonomic characters might be found in these structures, I have endeavored to examine the more pertinent literature dealing with the various systems and organs. From this source a considerable number of characters have been discerned which have direct bearing on the problem.

ACKNOWLEDGMENTS

This work has been done under the official direction of Dr. Raymond G. Stone, to whom I am grateful. I am deeply indebted to Dr. Edward H. Taylor for the larger part of the materials used in this study. I am also under obligation to the following persons who have been most accommodating in providing me with material otherwise not available: Dr. Sherman C. Bishop, Mr. Charles M. Bogert, Dr. Wilmer W. Tanner, Dr. Harry G. M. Jopson, and Dr. Robert C. Stebbins. I also extend my thanks to Mr. Lawrence F. Smith for the preparation of the drawings here included.

VERTEBRAL DIFFERENCES

Boulenger (1882: 2) and Cope (1889: 33) separated the Desmognathidae from the Plethodontidae chiefly on the basis of their vertebral articulation. The desmognathids were regarded as having opisthocoelous vertebrae while the plethodonts were considered as being amphicoelous. Moore (1890: 621) considered the vertebral articulation as the only character of significance that created distinction between these two families. He claimed that the condition of the vertebrae is dependent on the age of individual animals, and consequently of no value as a systematic character for the separation of families. While *Hemidactylium*, *Plethodon*, and *Aneides* never become opisthocoelous, he stated that *Pseudotriton ruber* and *Gyrinophilus porphyriticus* show a progressive ossification of the intervertebral cartilage throughout life until old adult specimens reach an opisthocoelous condition; and that a condition comparable to *Desmognathus* is reached in *P. ruber* at 180 mm. and in *G. porphyriticus* at 200 mm. in length. I have not been able to obtain specimens for investigation with these exact measurements In fact the largest specimen of *P. ruber* examined by Bishop (1946) was only 178 mm., two mm. short of that which Moore estimates as the probable length of his specimen. The largest specimen of *P. ruber* in the Museum of Natural History of the University of Kansas measures only 155 mm. I have procured through the kindness of Doctor Bishop a specimen of *G. porphyriticus* 190 mm. long, which approaches very closely the size of the specimen used by Doctor Moore. I dissected both specimens and I found what might be called a "false" opisthocoelous condition. Immediately after dissection the anterior vertebral articulation exhibits a bulbous condyle in both species, yet by simply touching or probing this structure one finds out that it is soft and not ossified. This fact is further confirmed when the vertebra is dried out and this knob shrinks back into the cup.

However, in *Desmognathus* and *Leurognathus* a true opisthocoelous condition is achieved at an early age. I have dissected a specimen of *D. ochrophaeus ochrophaeus* of only 55 mm. and one of *D. fuscus fuscus* 60 mm. in length in which already the process of ossification had extended beyond the border of the cup. Thus the morphological results of this process of ossification are present in *Desmognathus* throughout approximately the whole life of the animal. In such genera of plethodonts where this process is said to occur, its results are present only in the very old adult stages.

Saggital sections of the vertebrae of *Desmognathus, Thorius, Gyrinophilus* (140 mm.), *Pseudotriton* (135 mm.), *Pseudoeurycea, Plethodon,* and *Taricha* were made. To accomplish this the vertebrae were imbedded in transparent plastic blocks and then the surface was reduced to the desired level with fine sandpaper. The results have been decisive in demonstrating the clear cut differences in the vertebral articulations existing between the desmognathids and other genera of urodeles. The anterior part of the centrum of *Desmognathus,* as shown in Pl. X, fig. C, is a solid bony structure filling the cup and appearing homogeneous with the walls of the centrum leaving no trace of any part of a notochordal canal in the anterior half of the centrum of the vertebra. A solid condyle protrudes anteriorly. The posterior part is typically hollow. Thus the vertebrae are typically amphicoelous. *Thorius* and *Taricha* are externally opisthocoelous with a well-defined condyle. However, this is somewhat misleading since the anterior articulating condyle is merely a convex ossified cap fitting over the anterior opening of the cup, while the cup itself is hollow (see Pl. X, figs. A and B).

The notochordal canal of the centra of *Gyrinophilus* and *Pseudotriton* show notochordal cartilage, but no bone. Thus for all practical purposes they are still amphicoelous forms like *Plethodon.* (See Pl. X, figs. D and E). The cartilage present in the vertebrae occupies only the anterior edge of the cup, leaving a hollow cavity behind it. In still older forms this cartilage protrudes anteriorly in the form of a condyle in which there may be some deposition of calcium. However, this shrinks back upon drying, or if allowed to macerate will disappear completely. In the *G. porphyriticus* (190 mm. long), it was found that the posterior portion of the notochordal cartilage had become calcified or ossified, however, not filling the posterior part of the cup. This calcified portion did not extend forward to the edge of the cup and furthermore, unlike *Desmognathus,* it was easily distinguishable from the bony walls of the centrum. The condylar portion of the intervertebral cartilaginous mass still remained soft and shrank upon exposure.

The term, opisthocoelous, still describes externally the vertebrae of *Desmognathus, Leurognathus, Taricha,* and *Thorius;* and the term amphicoelous is likewise applicable to all plethodonts except *Thorius.* However, to differentiate between these forms the classification of vertebrae now needs something more than terms descriptive of external appearance. A sagittal section shows three very distinct internal conditions of the vertebral centrum. To describe these I propose the following terms:

The term "holocoelous," meaning entirely hollow, is proposed for that type of vertebral centrum typical of many plethodonts and various other primitive salamanders. This term is descriptive of the notochordal canal when there is no evidence of calcification or ossification of the material enclosed therein.

For the condition of the vertebral centrum in *Desmognathus* and *Leurognathus* the term "hemicoelous" or half hollow, is proposed. This term is descriptive of that condition in which the posterior half of the notochordal canal is hollow and the anterior half is solid bone including a condyle projecting from it.

"Pseudocoelous" is proposed to describe that condition of the notochordal canal such as obtains in *Thorius* and *Taricha*. Here the canal itself is hollow, yet it is covered at its anterior end by an ossified cap which, when observed from the outside, conveys a false impression of having a condition similar to that found in *Desmognathus*. It is also a term applicable to very old adult specimens of *Gyrinophilus* and *Pseudotriton* where there may be calcification within the centrum of a part of the notochordal cartilage.

But the condition of the vertebral articulation and the characteristics found in the centrum are not the only differences between the genera of Desmognathidae and the genera of Plethodontidae. Upon close examination of the vertebral column one finds further characteristics that thus far have only been suggested (Dunn 1926, and others), but not used in the differential taxonomy of the group. Dunn points out that the atlas of *Desmognathus* and *Leurognathus* is very different from that found in plethodonts. There is a gradual curving upward of the dorsal part of the arch of the atlas which forms a sharp-angled elevation where it meets the vertically arranged suprapostcrior surface (see Pl. XI, fig. B and C). This strong, sharp-edged, wide elevation serves as a posterior point of attachment for the tendon that immobilizes the temporalis muscle. This surface formed by the elevation also serves as an anterior point of attachment for the ends of some fibers of the dorsal longitudinal muscles. The atlas of plethodonts has a plane horizontal dorsal surface and there is no vertically arranged suprapostcrior surface as such. No doubt this elevation in *Desmognathus* and *Leurognathus* has been caused by the pulling stress of the temporal tendon upon the dorsoposterior angle of the atlas throughout the evolution of the forms.

The lateral articulating facets of the odontoid processes of the atlas of most, if not all, plethodonts are fused medially by a thin

sheet of bone. In *Desmognathus* and *Leurognathus* this ossification has not taken place and the two facets are distinctly separated and very much reduced, practically nonexistent.

The remainder of the vertebral column of *Desmognathus* and *Leurognathus* exhibits characteristics typical of most urodele vertebrae. However, there are pointed processes arising from the dorsal surfaces of the postzygapophyses of the anterior presacral vertebra which do not occur in plethodonts (see Pl. XI, figs. D and E). In younger specimens these processes are normally present only in the first three or four presacral vertebrae, excepting the atlas, but in older specimens these appear present to the tenth or thirteenth vertebra. I have not observed them present posterior to the thirteenth vertebra.

CRANIAL CHARACTERS

In studying the skull of *Desmognathus* and *Leurognathus*, I have followed an anteroposterior sequence. The skulls of these forms are relatively large, yet keeping a size which is related to the general proportions of the body. They are completely ossified units with firm sutures. The anteroposterior streamlining of the skull gives testimony to the aquatic evolution of the group. The widening of the external surface of the spines of the premaxilla is especially eloquent in this respect. In the characters of the premaxilla we find the main generic difference between *Desmognathus* and *Leurognathus*. The latter has no premaxillary fontanelle, while the former has a rather large one. Nevertheless both genera have the paired premaxillary foramina. The wedge shape of the snout in both forms must be the resultant of the underwater "rooting" habits of these forms.

The frontal bone that joins directly with the maxilla owing to the absence of a prefrontal, has a ventrolaterally directed process which arises from the side of the frontal bone, borders the anterior part of the orbit, and forms an osseous division between the nasal chambers and the orbits of the eyes. The origin of this process is open to speculation. It definitely is not present in the related families Plethodontidae and Salamandridae.

The parietals have been subjected to great stress by the temporalis muscle and its contained tendon. This muscle runs along the dorsal surface of the parietal where the latter forms a suture with the periotic. It then turns ventrally on the anterior edge of the parietal to insert on the coronoid process of the mandible. A rounded groove in which the muscle lies, is present on the dorsal surface of the bone

and, furthermore, the portion of the parietal bordering the orbit has been extended somewhat forward, thus considerably reducing the length of the orbit. In most plethodonts the length of the orbit is approximately one half or more of the total length of the skull. However, in *Desmognathus,* owing to the condition of the parietals, the length of the orbit is about one third of the total cranial length.

Another striking difference between the Desmognathidae and the Plethodontidae is the morphology of the occipital condyles. In the plethodonts which I have examined the condyles are sessile and their articulating surface are either plane or concave. In *Desmognathus* and *Leurognathus* there are two stalked condyles measuring one or two millimeters in length, extending posteriorly from the skull, and with a convex surface to articulate with the concave facets of the atlas.

The morphology of the mandible provides a constant difference which is undoubtedly of taxonomic value. The coronoid bone of most plethodonts forms a low, gently tapering, elliptical curvature on the posterodorsal edge of the mandible. But in *Desmognathus* and *Leurognathus* the temporalis and its stress on the adjacent bones have produced a change from this form, and the coronoid process formed in these genera is an acute, pyramidal elevation of the posterodorsal edge of the mandible. Its upper tip is the point of insertion of the temporalis. One may readily infer that this, just as the already described peculiar formation of the atlas and the grooving of the parietal area of the skull, is a result of the stresses of the temporal tendon. This also shows one example in amphibians of what Gregory (1933: 446) has so painstakingly shown in fishes when he says: "The facts cited in this paper sufficiently prove that in the skull of the fish, just as in the mammalian skeleton, bony trabeculae, ridges, buttresses, etc., arise in response to specific stresses, such as those generated by the thrusts of one moving part upon another, in other words, that bones are usually strengthened in proportion to the loads they bear."

DENTITION

Relatively little work has been done on the dentition of salamanders in general. The teeth of salamanders are usually very small and in live and preserved specimens they are partially concealed under a layer of epithelium. Nevertheless, in skeletons the dentition may be easily studied under a low power microscope. Desmognathids and plethodonts usually have pleurodont teeth arranged along the buccal ridges of the maxilla, premaxilla, and mandible.

However there is a considerable variation among plethodonts as to the maxillary teeth. While *Thorius* has an edentulous maxilla,* *Batrachoseps* has various rows of teeth along the maxilla. Both families also have vomerine and paravomerine† patches of teeth. These may be arranged in either continuous or discontinuous patches. Male desmognathids tend to lose the vomerine teeth, this effect being more accentuated in some species than in others. This tendency to lose completely the vomerine teeth is not found in plethodonts.

Noble in 1927 and Noble and Pope in 1929 linked dentition in *Desmognathus* to secondary sexual characteristics. Secondary sexual dimorphism is evident in many other urodele genera, but its effects in desmognathids are unique and quite different from those found in other forms. The tendency to complete loss of the vomerine teeth seems to be restricted to desmognathids alone. Other secondary sexual characteristics like the elongation and forward protrusion of the premaxillary teeth and the tendency to lose the posterior maxillary teeth are mutually shared with some genera of plethodonts and perhaps other families.

THE HYOBRANCHIAL APPARATUS

One of the most significant differences between the Desmognathidae and the Plethodontidae is found in the hyobranchial apparatus of the larvae of *Desmognathus* and *Leurognathus*. Mrs. Wilder (1913: 300) had already noticed in her study of the life history of *Desmognathus* the presence of four gill slits in the larvae of these forms. But this condition did not seem extraordinary to her as she correctly considered the genus to belong to the family Desmognathidae. This is a radical departure from the typical condition in the larvae of the Plethodontidae which have only three gill slits. However, more recently, Hilton (1947: 191), after examining the hyoid apparatus, comments as follows: "In all the genera of Plethedontidae examined, two only have four pairs of branchial arches, *Desmognathus* and *Leurognathus*. This may show that these are closely related and also suggest that they are more definitely related to other groups than the rest of the family so far known, for they all have the rather distinctive number of three pairs of branchial arches."

The adult hyobranchial skeleton of *Desmognathus* has been studied by Piatt in 1935 and compared with that of various genera

* Cope in his "Batrachia of North America," Pl. 37, figs. 2-4, shows a skull labeled as *Thorius pennatulus*, having maxillary teeth. This is obviously an error, as all the known species of *Thorius*, including *T. pennatulus*, have an edentulous maxilla.

† I follow Taylor (1944: 206) in the usage of the term paravomerine for the patches of teeth appearing on two thin bony plates ventral to the parasphenoid bone.

of the Plethodontidae. The adult structures are basically similar, except for a few details of size and shape.

MYOLOGICAL CONSIDERATIONS

Most striking muscular differences in salamanders are found in the musculature of the neck and the throat. This general region exhibits changes in both the superficial and the deep muscles of the various genera which are usually associated with the adaptations of the hyoid appartus. *Desmognathus* and *Leurognathus* are no exceptions; in fact some of the most pertinent differentiations between the Desmognathidae and other families are found in the character and extent of development of this musculature.

There are two pairs of muscles in Desmognathus and Leurognathus that are extraordinarily developed when compared to analogous muscles in other salamanders. On the dorsal side of the animals we find the curious M. temporalis which has its origin on the posterodorsal margin of the atlas and whose fibers encircle a strong tendon that passes forward over the surface of the cranium, turns ventrad on the posterior edge of the orbit of the eye and is inserted on the tip of the coronoid process of the mandible. This tendon immobilizes the muscle and consequently the mandible, as Dunn (1926: 59) has indicated. To open their mouths desmognathids have to raise the whole skull and this is accomplished by the powerful dorsal and lateral muscles of the neck. Here is a condition different from any other family of salamanders, one that I regard as of invaluable taxonomic importance.

On the ventral side of desmognathids we find a bilobate enlargement of the gular region by means of which members of the family can be readily recognized externally. Its prominence gives this family what Piatt (1935: 222) has called "the characteristic *Desmognathus* profile." This enlargement so noticeable externally, is caused by the tremendous development of the gularis muscle‡ in those forms. Upon removal of the skin these muscles stand out very prominently (see Pl. XI, fig. A). They originate on the quadrate, the articular, and the dorsolateral fascia; their insertion is on the skin of the gular fold and the pectoral fascia.

An interesting condition in the myology of salamanders is the direct correlation between the extent of attachment of the tongue and the posterior reach of the M. subarcualis rectus, the muscular cup

‡ Piatt (1935: 222) and (1940: 10) has shown that this structure is really made up of two separate muscles, a large quadrato-pectoralis and a small, delicate gularis. However, Eaton (1937: 324) pointed out the convenience of using the name gularis to denominate the entire structure for purposes of simplicity.

that encloses the ceratobranchial cartilage and which is primarily used in extending the tongue (Francis, 1934: 61). All desmognathids have an attached tongue, while the Plethodontidae, with its great variety of genera, has forms in which the tongue has become freed from the floor of the mouth and capable of considerable protrusion. Those plethodontid forms with attached tongues may be regarded as more primitive. Plethodontid salamanders of the genera *Eurycea* and *Pseudotriton*, with a tongue free all around, have a long, far reaching subarcualis rectus, while the genera of Desmognathidae, together with those genera of plethodonts that have the tongue attached in front, have a shorter, subarcualis rectus. It seems that the tongue attachment tends to hinder the development of the subarcualis rectus, as the maximum extension of the tongue is definitely limited to a fixed measurement by this attachment. However, in those forms where there is no lingual attachment, the movement of the tongue has no other limit except that imposed by the maximum action of the subarcualis rectus itself.

Another noticeable and presumably important character is the position assumed by preserved specimens of *Desmognathus* and *Leurognathus*. Their head is bent downward giving a pronounced *rigor mortis* appearance on the anterior part of the body with the nape raised as the apex of an inverted letter V. This would suggest some unknown inherent quality of the musculature which is not present in the Plethodontidae. I have not been able to observe this peculiar condition in any other forms.

CIRCULATORY AND RESPIRATORY SYSTEMS

I have made no original study of the circulatory and respiratory systems of the Desmognathidae. However, I have examined such papers as would seem pertinent in this field. Among these the most important is the article by Seelye in 1906. Here a study was undertaken of the similarities and differences between a representative member of the family Desmognathidae, *Desmognathus fuscus*, and a member of the family Plethodontidae, *Spelerpes fuscus* [=*Hydromantes genei italicus*]. This work was in turn partially based on the work done on *Hydromantes* by Bethge in 1898. No differences were found in the respiratory system, yet a résumé was made of the differences in the circulatory system which I quote as follows:

"1. The vena subclavia entering the sinus venosus directly, instead of first opening into the ductus Cuvieri; and the right and left venae subclaviae opening together into the sinus on its left side.

"2. The vena abdominalis arising, not from the venae iliacae, but from the venae iliacae communes.

"3. A side tributary of the vena lingualis, observed, however, only on the left side.

"4. The arteria cutanea, a branch of the arteria pulmonalis, instead of a branch of the arteria subclavia.

"5. Four arteriae gastricae at anterior end of stomach, instead of two; three of these go to one side (the left).

"6. The presence of the arteria epigastrica, an important branch from the aorta just anterior to the arteria iliaca."

After considering these facts one is led to the conclusion that these differences are of taxonomic importance. It is not only one single detail, but an accumulation of differences between *Desmognathus* and *Hydromantes* in the morphological structures of one single system which seem to indicate no less than distinction on the family level.

REPRODUCTIVE SYSTEM

The testes and vasa deferentia of all members of the family Desmognathidae are covered by a deeply pigmented mesentery of coal black color. Since the first part of the century many biologists have tried to associate testicular pigmentation with external stimuli. Considerable evidence has been accumulated on the effects of light and temperature upon this pigment, but most of it is conflicting. Only of late, Finkel in 1945, has finally and definitely linked testicular pigmentation with sex hormones in opossums and ground squirrels. This work does not eliminate the strong possibility of establishing a correlation with external stimuli, but on the contrary it has indicated the necessity for such further investigations.

A few members of the genus *Plethodon* of the family Plethodontidae likewise have developed pigmented genitalia. However, I believe this case is not an illustration of relation, but one of parallel development.

NERVOUS SYSTEM

In the literature of the nervous system of salamanders, Murray (1897) has made a comparison between the ramifications of the spinal chord and nerves of the three forms: *Desmognathus fuscus, Plethodon erythronotus* [= *P. dorsalis*], and *Spelerpes fuscus* [=*Hydromantes genei italicus*]. He has noted a characteristic which I believe adds weight to the differentiation of the families Desmognathidae and Plethodontidae. He found that in the three forms the spinal nerves pierce the neural arch, however in *Plethodon*

the dorsal and ventral roots of the spinal nerve are separated by a ridge of bone on the inner surface of the neural arch. The foramen of exit, however, is single. A different condition from this last one obtains in *Desmognathus* where the dorsal and ventral roots of the spinal nerves leave the osseous canal by separate foramina.

GLANDS

Another characteristic of the soft anatomy of the Desmognathidae which undoubtedly has bearing on taxonomic differentiation between these forms and plethodonts, is that which Mrs. Wilder (1913: 315) has noted when she studied the development of the naso-optical region in *Desmognathus*. I quote: "In connection with the development of the orbital glands it should here be noted that unlike all Urodeles (so far as the facts have been reported), *Desmognathus* has no nasolacrimal ducts. As these are present in so closely related and associated forms as *Spelerpes* and *Plethodon*, as well as in the less closely related lunged forms, their absence here has some significance which demands further study of the comparative morphology and the habits of these species."

The members of the Desmognathidae develop a submental gland in the male as a secondary sexual characteristic. Dunn (1926) and Noble (1927) have already discussed these glands. Their function seems to be hedonic. In the Desmognathidae these glands are restricted to the very anterior tip of the chin, immediately ventral to the mandibular symphysis. In this family they are composed of five or six separate fingerlike glandules arranged in a typical shape. There are submental glands in the Plethodontidae; however, their characteristics are very different from the analogous structures in the Desmognathidae. In the genera of plethodonts that I have examined the glands are flat, circular clusters of globules attached to the inner side of the skin just ventral to the floor of the mouth.

There are three sets of glands located along the walls of the cloaca of male salamanders. These glands have been found by Noble and Pope (1929) to have reproductive and hedonic functions. The anterior pair are the pelvic glands whose secretion mixes with the spermatozoa to form the head of the spermatophores. The papillae of the cloacal glands form the greater part of the villous pad on either side of the cloaca. The abdominal glands simulate a pair of wings on the posterior angle of the cloaca. In the Desmognathidae the abdominal glands have a peculiarly hard texture when compared to the same glands of other families and to the softer and fluffier pelvic and cloacal glands of the same forms. In many speci-

mens I have observed a peculiar coloration of these abdominal glands that varies from light pink to light brown. I have not found this coloration in any species belonging to other genera.

CHARACTERS OF THE FAMILY DESMOGNATHIDAE

Future work on this problem, if directed to the soft anatomy, and especially the microscopic anatomy of the Desmognathidae will doubtless yield added evidence for the differentiation of the Desmognathidae from the Plethodontidae. Points of resemblance between the two families suggest common ancestry, or parallel development. The facts evinced from this re-examination of the problem more than suffice to confirm the separation into the two distinct families. In summation, the following combination of characters may be regarded as defining the family Desmognathidae:

1. True opisthocoelous vertebrae.
2. Hemicoelous centra.
3. A nasolabial groove present.
4. Lungs absent.
5. Tongue adherent in front and by the middle.
6. Larvae with four epibranchials.
7. Highly modified atlas.
8. Carpus and tarsus not ossified.
9. Strong tendon present in M. temporalis which immobilizes the mandible.
10. Highly developed gularis muscles.

GENERA OF DESMOGNATHIDAE

The family Desmognathidae, as known today, comprises the two genera *Desmognathus* and *Leurognathus*. They are almost identical when observed externally. The main external difference between them is the presence of a groove from the eye to the angle of the jaw in *Desmognathus* and its absence in *Leurognathus*. This near identity has resulted in confusion and *Leurognathus* has often been mistaken for *Desmognathus* by workers in the field. However, Moore (1899), Bishop (1924), and Pope (1924 and 1928) have noted the behavior peculiar to each of these genera and on this basis they are able to distinguish them. When *Leurognathus* is exposed in water by turning a stone it either lies quietly on the bottom or glides gracefully to cover under water. This response is in sharp contrast to the darting, vigorous swimming movements of *Desmognathus quadramaculatus* or *Desmognathus phoca* when disturbed.

The basic generic differences between *Desmognathus* and *Leurog-*

nathus are easily discerned upon examination of the skull. Neither the premaxilla nor the vomerine bones of *Leurognathus* embrace a fontanelle as in *Desmognathus*. This condition gives the anterior part of the skull of *Leurognathus* a completely roofed appearance. The choanae of *Leurognathus* are small foramina hidden in a fold at the sides of the roof of the mouth. In *Desmognathus,* however, these are conspicuous, plainly observable openings. The ratio of the length of the orbit to the total length of the skull is higher in *Leurognathus* than in *Desmognathus*. Nevertheless after these generic differences are noticed we find that endless stream of similarities which classify these two forms as two closely related genera within the family Desmognathidae.

The loss of the type of the mysterious *Haptoglossa pressicauda* Cope allows us only to speculate as to the kinship of this form. This species was placed by Cope in the subfamily Thoriinae under the family Desmognathidae. From the description given by Cope (1893: 334) this genus could belong to the family Desmognathidae as we see it today. However, we shall never determine its exact taxonomic position until the species is again found. Dunn (1926: 429) doubtfully synonymizes this form with *Oedipus uniformis* [= *Oedipina uniformis*], yet I fail to understand how he can reconcile the adherent tongue, the compressed tail, and the relative sizes of the head, body, and tail as described by Cope with those of *Oedipina uniformis* that has totally different characters. This form could also be a plethodont, as none of its characters is conflicting with the wide variety found in this family. The family association will depend upon ascertaining the character of the vertebral structure and articulation, and other family characteristics.

As previously stated *Thorius* Cope and *Typhlotriton* Stejneger were at one time included in the family Desmognathidae. *Thorius,* however, may be promptly eliminated from it on the basis of its pseudocoelous centra, dorsal skull characters, the orbitolabial groove, the normal atlas, its free tongue, and the absence of highly developed gular muscles. I have not examined adult specimens of *Typhlotriton*, but from Moore (1900: 620) I infer that it has pseudocoelous vertebrae. This last genus may be also eliminated from the family Desmognathidae on the strength of its normal atlas and the presence of a prefrontal bone. Dunn (1926: 251) has conclusively associated this genus with the plethodontid group close to *Eurycea,* and proved its lack of relationship with the family Desmognathidae.

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EXPLANATION OF PLATE X

FIG. A. *Thorius narisovalis,* No. 25216 EHT-HMS.

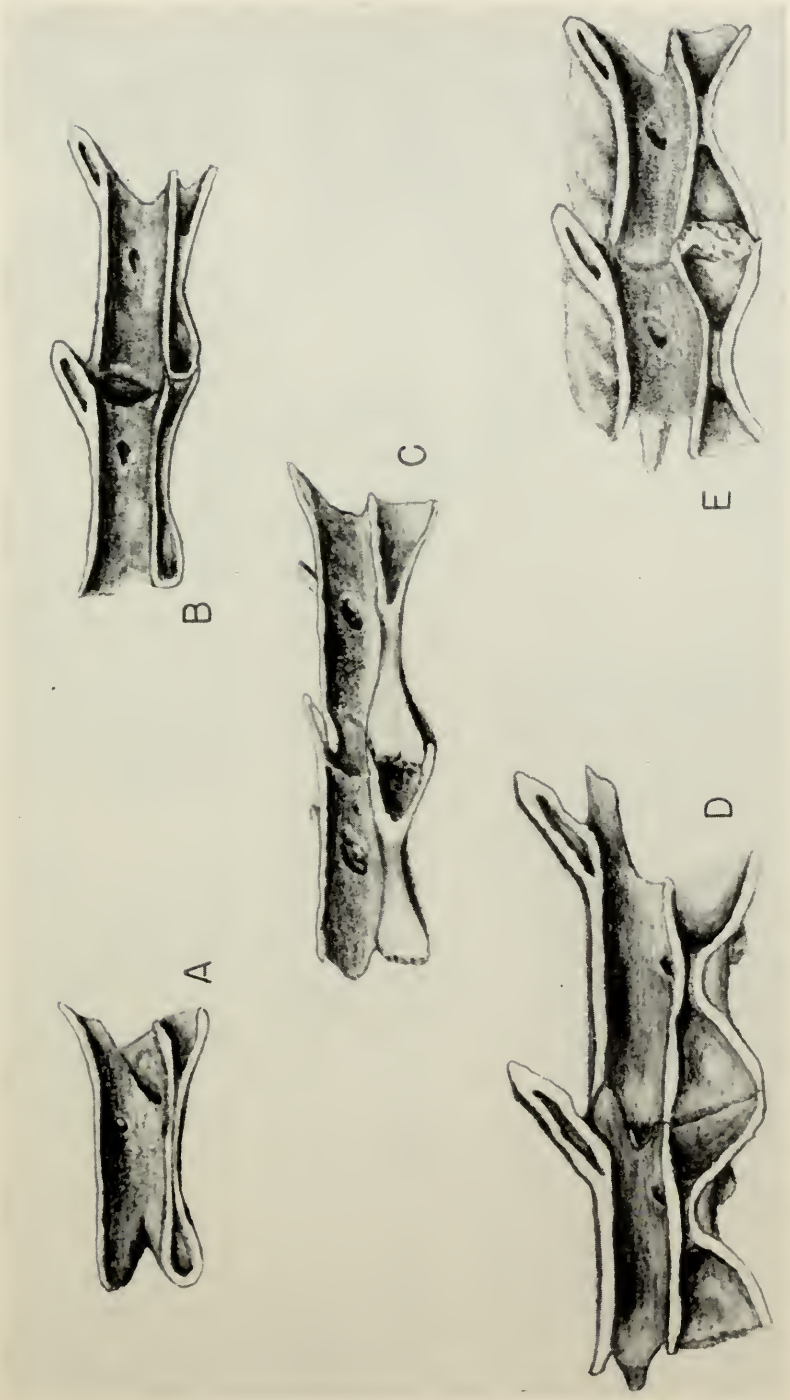
FIG. B. *Taricha torosa,* No. 18263 M.V.Z.K.U.

FIG. C. *Desmognathus fuscus fuscus,* No. 28293 EHT-HMS.

Fig. D. *Pseudotriton ruber ruber,* No. 19450 M.V.Z.K.U. (specimen 135 mm. in length).

FIG. E. *Gyrinophilus porphyriticus porphyriticus,* No. 28272 EMT-HMS (specimen 140 mm. in length).

PLATE X



Sagittal sections of presacral vertebrae (enlarged)

PLATE XI

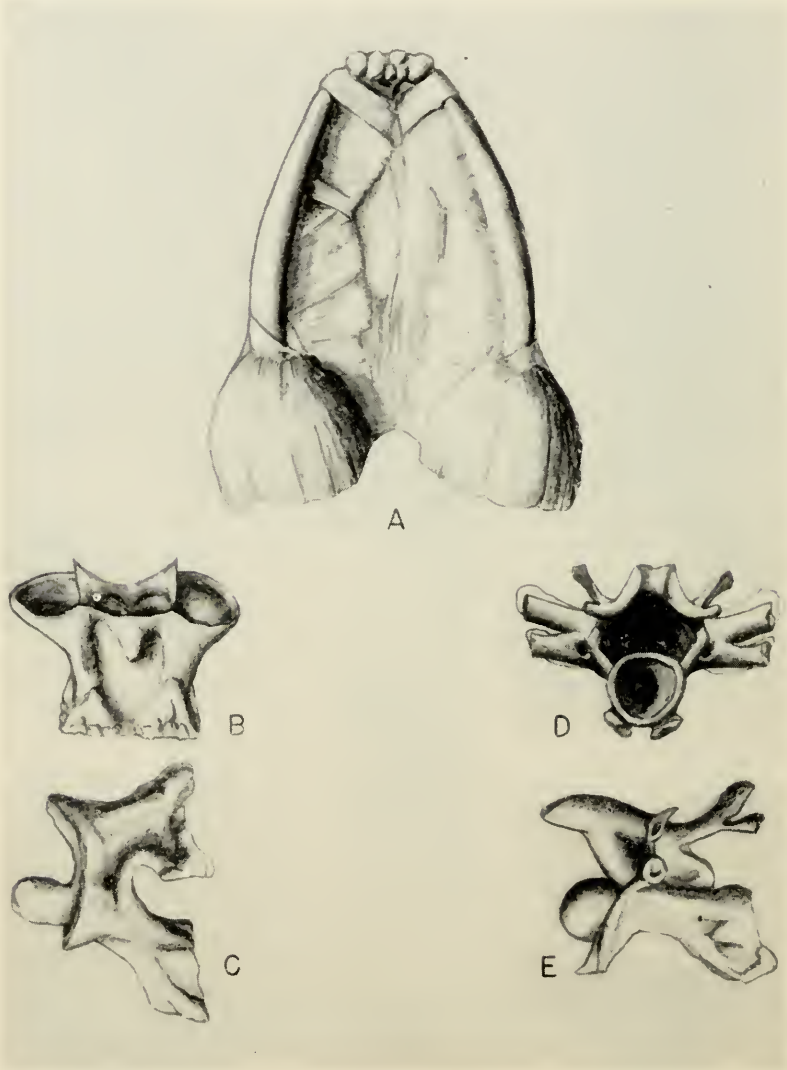


FIG. A. Ventral view of the throat musculature of an adult male of *Desmognathus ochrophaeus ochrophaeus*, showing the development of the gularis muscles and the submental gland.

FIG. B. Dorsal view of the atlas of *Desmognathus fuscus fuscus* showing the reduction of the odontoid process.

FIG. C. Side view of the atlas of *D. fuscus fuscus* showing the transverse ridge for the attachment of the temporal tendon.

FIG. D. Posterior end view of anterior presacral vertebra of *D. fuscus fuscus* showing the processes arising from the postzygaphophysis.

FIG. E. Side view of D.

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Ceylonese Lizards of the Family Scincidae

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ABSTRACT: This paper treats of Ceylon scincoid lizards in the collections of the United States National Museum, together with those in the Edward H. Taylor-Hobart M. Smith Collection at Lawrence, Kansas.

In this paper the following species are described as new: *Mabuya floweri, Riopa singha, Sphenomorphus deignani, Sphenomorphus rufogulus,* and *Nessia deraniyagalai.* One species, *Mabuya madarászi* Méhely is removed from the synonymy of *Mabuya macularia* Blyth, and re-established.

All the known forms are listed and keys are given for the species of the various genera. Altogether six genera occur with the 25 species distributed as follows: *Mabuya,* 6 species; *Dasia,* 1; *Riopa,* 2; *Sphenomorphus,* 7; *Chalcidoseps,* 1; and *Nessia,* 8.

This is the second * of a series of studies on the herpetological fauna of Ceylon. The materials on which this study has been based are the Ceylonese specimens of the U. S. National Museum and those in the Edward H. Taylor-Hobart M. Smith collection at Lawrence, Kansas (EHT-HMS). In the first collection there are 367 specimens; in the latter, approximately 1,000.

The source of the material in the U. S. National Museum is varied. Certain specimens represent the result of exchanges with various European museums; some with the museum in Colombo, Ceylon. A considerable number are from the J. Hurter collection that likewise contained material from a variety of sources. Nearly one third of the collection is a recent lot collected by Dr. H. G. Deignan of the National Museum, in the Kandy and Matale Districts of the central highland region of Ceylon.

* Edward H. Taylor. Comments on Ceylonese Snakes of the Genus *Typhlops* with descriptions of new species. Univ. Kansas Sci. Bull., vol. 31, pt. 2, Nov. 1, 1947, pp. 283-298, figs. 1-3. (First study.)

30—90

The material in the EHT-HMS collection, with a few exceptions, is a recently collected lot obtained by me, chiefly from the region about Trincomalee, Ceylon, with a scattering of specimens from other localities on the island.

The present study deals with the lizard family Scincidae, which is very well represented by six genera and 25 species. Five of this lot are regarded as new, and one form, *Mabuya madarászi* Méhely, is removed from the synonymy of *Mabuya macularia* and re-established.

The following forms occur in Ceylon:

* Mabuya bibronii
* Mabuya macularia
* Mabuya beddomii
Mabuya floweri
* Mabuya carinata
Mabuya madarászi
* Riopa punctata
Riopa singha
Dasia haliana
* Sphenomorphus dussumieri
Sphenomorphus megalops
Sphenomorphus deignani
Sphenomorphus striatopunctatus
Sphenomorphus taprobanense
Sphenomorphus fallax
Sphenomorphus rufogulus
Chalcidoseps thwaitesi
Nessia burtonii
Nessia didactyla
Nessia monodactyla
Nessia bipes
Nessia sarasinorum
Nessia hikanala
Nessia layardi
Nessia deraniyagalai

The faunas of Ceylon, as regards their relationship to those in nearby land masses, seem to be paradoxical at times. Thus in certain genera the relationship is close; in others there is no apparent relationship whatever. Thus *Mabuya* is represented by six species in Ceylon, four of which are regarded as identical with those in India; two are endemic, or at least have not yet been reported in mainland India. On the other hand, *Nessia* has eight species, none of which occurs in India. In this case the relationship seems to be with South Africa and Madagascar where the genus *Acontias* occupies the same niche and has undergone a somewhat similar evolution. Most, if not all, of its African and Madagascar species have lost the limbs, and the scales are more highly specialized. Boulenger (1887)† regarded *Acontias* and *Nessia* as belonging to a single genus. However, a more recent proposal has been made for their separation by Hewitt (1929)‡.

* Species marked with an asterisk represent forms also occurring in India.
† Cat. Lizards British Mus., vol. 3, 1887, p. 424.
‡ Ann. Transvaal Museum vol. 13, 1929, p. 8.

Essex (1928)¶ has suggested that *Acontias* and *Nessia* represent the same stock but that they are end products of two divergent streams from an unknown center. That this center is not in continental Asia seems obvious.

Chalcidoseps is a relict monotypic genus known only from Ceylon, and may represent a survivor from a group, similar to *Nessia,* that has undergone a similar evolution. There are other monotypic genera of the same sort scattered throughout the southeastern part of Asia and the Indo-Malayan Archipelago. They likewise seemingly represent survivors of former specialized series of species. *Barkudia* and *Sepsophis* in India are typical examples. I am convinced that *Lygosoma quadrupes* § represents a single remaining form of a similarly specialized group. I would consider *Ateuchosaurus* as a representative of another specialized group; *Ophioscincus* represents another series with three living forms.

The two species of *Riopa* are closely related (*singha*), or identical (*punctata*), with Indian species. *Dasia,* belonging to an arboreal group of skinks, seems to be related most closely to species that exist in the Indo-Malayan Archipelago and the western Pacific Islands. A south Indian form exists (*subcoerulea*), but the relationship of this species is with eastern Asiatic forms and not with the Ceylonese species, despite the fact that there is a very considerable hiatus in the distribution of the genus in central and eastern India, Burma and Siam.

Mabuya is a genus of wide distribution (South Asia, Indo-Malaya, Africa, Central America, South America and West Indies). It is ultraconservative and, like *Eumeces,* has developed no very highly specialized types, although there is a tendency to greater specialization (small size) in Florida and west México in the latter genus. In ultraconservative species, changes of lesser extent are perhaps of greater significance than in the more plastic groups.

¶ Studies in Reptilian Degeneration. Proc. Zool. Soc. London, (1927) 1928, pp. 879-945, text figs. and plate.

§ I cannot agree with Dr. Malcolm Smith, 1937, in considering *Lygosoma quadrupes* as one of a specializing or "degenerating" series that includes *Sphenomorphus* and perhaps other genera (see Rec. Indian Mus., vol. XXXIX, part III, 1937, pp. 213-234).

KEY TO THE GENERA OF SCINCIDAE IN CEYLON

1. Palatine bones in contact or overlapping along medial palatal line 2
   Palatine bones not in contact along medial palatal line 6
2. Supranasals present 3
   Supranasals absent 5
3. Scales keeled with from 2 to 7 keels 4
   Scales smooth; body somewhat elongated; limbs pentadactyl, but short; widely separated when adpressed; scales smooth; lower eyelid with a semitransparent disk ..... *Riopa*
4. Pterygoid bones not in contact, the palatal notch extending forward to level of centers of eyes; limbs pentadactyl, well developed, distinctly overlapping when adpressed; no distinct transverse bands ..... *Mabuya*
   Pterygoid bones in contact anteriorly, the palatal notch not reaching forward to level of centers of eyes. Limbs pentadactyl, failing to touch or barely overlapping when adpressed; color pattern of transverse bands ..... *Dasia*
5. Limbs pentadactyl, meeting, overlapping or failing to meet when adpressed; lower eyelid scaly; frontoparietal single or double; scales smooth or at most, with slight suggestion of keels or striations ..... *Sphenomorphus*
   Limbs not pentadactyl, greatly reduced or absent; body anguiform; the nostril in rostral 6
6. Nostril in anterior part of rostral, connected to the posterior edge of scale by a groove; limbs variable, never tetradactyl ..... *Nessia*
   Nostril near the posterior edge of rostral; limbs short, tetradactyl ..... *Chalcidoseps*

GENUS MABUYA Rafinesque

Mabuya Rafinesque, Anal. Nat., 1815, p. 76 n.n.

Genotype.—Lacertus mabouya Lacèpéde (not *Scincus Sloanii* Daudin *fide* Malcolm Smith, Fauna of British India, Rept. Amph., vol. 2, Sauria, 1935, p. 257).

Six species are recognized as occurring in Ceylon.

KEY TO SPECIES OF MABUYA IN CEYLON

1. A transparent disc on lower eyelid ..... *bibronii*
   No transparent disc, but several larger transparent scales on lower eyelid 2
2. A postnasal ..... *macularia*
   No postnasal 3
3. Scales almost smooth or with three to five very feeble keels ..... *beddomii*
   Scales not smooth, each bearing 3, 5, or 7 strong keels 4
4. Scales tricarinate (or sometimes also with a small tubercle on outer edge of scale); dorsum with a paired series of black markings ..... *floweri*
   Scales with five or seven keels (except very young which may have three); no paired series of black markings on dorsum 5
5. Larger; snout to vent, 125 mm.; adpressed hind limb to wrist or elbow ..... *carinata*
   Smaller; snout to vent, 77 mm.; adpressed hind limb to axilla or farther ... *madarászi*

Mabuya bibronii (Gray)

Tiliqua bibronii Gray, Ann. Mag. Nat. Hist., vol. 2, Dec., 1838, p. 290 (type locality unknown).

Mabuia bibronii Haly, Report on the collection of Reptiles and Batrachia in the Colombo Museum; Colombo, 1891, p. 14 (Mullaittivu, Eastern Province); Annandale, Spolia Zeylanica, vol. 3, pt. 11, Jan., 1906, p. 190 (Ceylon); Deraniyagala, Ceylon Journ. Sci., sec. B, vol. 16, pt. 2, 1931, p. 164; Hora, Rec. Indian Mus., vol. 29, pt. 1, p. 1, pl. I, fig. 4 (comment on habitat).

Mabuya bibronii Smith, The Fauna of British India including Ceylon and Burma; Reptilia and Amphibia, vol. 2, Sauria, Feb. 7, 1935, pp. 260-261 (Chundikulam, Eastern Province).

No specimens of this species are at hand. Its known distribution in Ceylon seems to be on the eastern coast.

It may be distinguished from other known Ceylonese forms by the presence of a rounded, undivided, semitransparent disk in the lower eyelid; two pairs of nuchals; scales 5-to 7-keeled; a postnasal, and 28-30 scale rows. The snout to vent length is 50 mm. It has been reported only from Eastern Province.

Mabuya macularia (Blyth)

Euprepes macularius Blyth, Journ. Asiatic Soc. Bengal, vol. 22, 1853, p. 652 (type locality, ?Rangpur, Bengal).

Mabuia macularia Deraniyagala, Ceylon Journ. Sci., sec. B, vol. 16, pt. 2, 1931, p. 165.

Mabuya macularia (part) Smith, Fauna of British India including Ceylon and Burma; Reptilia and Amphibia, vol. 2, Sauria, Feb. 7, 1935, pp. 264-266.

The collection contains two specimens of this species (U. S. N. M. No. 29410 and 120325) collected by D. L. Karcher, Ceylon, Clodagh Estate, Rattota, Matale District. These differ in certain characters and if the differences are not due to age, may possibly represent two forms.

No. 29410. Part of rostral visible above less than half length of frontonasal which it touches, separating the internasals; latter nearly one third wider than long; prefrontals forming suture; parietals separated by interparietal which is distinctly longer than broad; two supraoculars touch frontal; length of parietal 1⅓ times in width; parietal partly segmented on left side; a postnasal present; first loreal at least twice as high as long, about half length of posterior loreal; four supraoculars; five superciliaries; three anterior temporals; lower eyelid with quadrangular scales; seven upper labials; mental much shorter than postmental; first pair of chinshields separated; second pair separated by a single scale; third pair (one of the pair segmented longitudinally) separated by three scales; seven (or eight) lower labials; 25 scale rows, the 12 ventrals smooth, the remainder keeled with five, six, or seven keels; temporals practically smooth; scales under base of tail small becoming widened posteriorly both ventrally and dorsally; subdigital lamellae on fourth toe, 13-15. Eight or ten axillary rows of granular scales, forming a pocket; two small granular rows behind leg insertion; no modified scales on posterior surface of thigh; hind leg reaches somewhat beyond wrist of adpressed arm; nearly uniform olive above with a broad lateral brown band bearing numerous streaks or flecks of white.

No. 120325 is a larger adult that differs from the smaller (and younger) in several points: The prefrontals separated, and first supraorbital separated from frontal; series of scales in the axilla somewhat fewer and pocket not well defined; scales on posterior part

of femur show distinct modification in having a small patch of enlarged soft scales near limb insertion.

There is of course the possibility that two separable forms are represented by these two specimens. They agree in the following characters: The first chinshields are separated, and the mental is much narrrower than the postmental. The part of the rostral visible above is less than half the length of the frontoparietal. The white spots on the sides are strongly evident. The hind limb reaches half way between wrist and elbow of the adpressed arm.

A larger series of specimens will be necessary to determine the status of the variation.

Mabuya beddomii (Jerdon)

Euprepes beddomii Jerdon, Proc. Asiatic Soc. Bengal, Mar., 1870, p. 73 (type locality, Mysore, India).

Mabuya beddomii Smith, The Fauna of British India including Ceylon and Burma. Reptilia and Amphibia, vol. 2, Sauria, Feb. 7, 1935, pp. 274-275 (Punduloya).

A series of four specimens taken 12 mi. N of Trincomalee are referred to this Asiatic species.

The characteristics of these four specimens follow: supranasals broadly in contact; frontonasal very much reduced, much wider than long; prefrontal broadly in contact; six superciliaries; a pair of nuchals; no postnasal; eyelid with three or four enlarged scales; first pair of chinshields separated; dorsal and lateral scales rather weakly keeled, with three or (rarely) five keels; temporal scales smooth; the length of parietal contained in width, $1\frac{1}{3}$ times; height of subocular about one half its length; 30 or 31 scale rows around middle of body.

Dorsal surface brown with a short, whitish, black-edged stripe beginning on nuchals and extending to a line drawn in front of arm insertion; a broad dorsolateral dark stripe to some distance on tail bordered above by a very narrow cream line and below by a broader (two half scale rows wide) white or cream line; this light line bordered below by a dim dark line; lateral cream line, arising on upper lip passes for the most part above, rather than through, ear; venter immaculate white.

These Ceylon specimens differ from the continental Indian specimens in having the middorsal line much reduced. The very young (26 mm.) specimens show the same marking as obtains in the largest (53 mm.). Whether there are likewise stable differences in squamation cannot be determined from the material at hand.

Mabuya floweri sp. nov.

Type. EHT-HMS No. 30507. Collected 12 mi. north Trincomalee, Ceylon, Sept. 3, 1944. E. H. Taylor, collector.

Paratype. No. 30506, same locality and collector.

Diagnosis. A small, terrestrial species; scales for the most part tricarinate having transparent part of eyelid broken into three or four short quadrangular scales; frontal short, equal to or minutely less than its distance from tip of snout, shorter than combined length of interparietal and frontoparietals; no postnasal; supranasals separated; prefrontals and parietals also separated; first chinshields separated; six superciliaries; a well-defined, swollen (glandular?) area on posterior part of thigh, covered with large, irregular, more or less pointed scales; 30 scale rows about body, the 12 ventral scale rows smooth, the 18 dorsal and lateral scale rows heavily keeled.

Description of the type. Rostral folding back over snout, the part visible above less than half length of frontonasal with which it is in contact, thus separating supranasals; latter scales narrow, elongate, separated by a distance equal to one third of their length; frontoparietal nearly one fifth wider than long, forming a suture with frontal and separating large prefrontals; frontal about one fifth longer than frontoparietals; interparietals short, about as wide as long; greatest length of parietals contained in width about one and one fourth times; a well-developed pair of nuchals; second supraocular alone touching frontal, both second and first touching prefrontal; four supraoculars; suture between rostral and first labial when extended upward passes somewhat in front of nostril; nasal definitely a single scale; no postnasal present; anterior loreal distinctly higher and narrower than second; two presuboculars; four postsuboculars diminishing in size, the upper separated from last supraocular by a single scale that is in contact with last superciliary; three primary and three secondary temporals; four supralabials precede and two follow the subocular which is two and one half times longer than high; three bluntly pointed ear lobules; four large rectangular scales on eye; eight or nine infralabials; a large postmental in contact posteriorly with a small median scale separating the first pair of chinshields; second pair separated by a single scale, third pair by three scales; ear opening circular, its diameter less than transparent part of eyelid; scales in 32 rows about body, 12 ventral rows smooth, 18 dorsal and lateral rows strongly tri-

carinate with sometimes an additional outer tubercle or keel on scales from nuchals to base of tail; the keels form nearly continuous lines arranged in groups of three, these groups distinctly separated from the next series of three by a space that is distinctly wider than that between keels of the rows forming the series; dorsolaterally the outer edges of the scales show a tiny tubercular elevation or a fairly well-defined keel; on tail, scales are bi- or tricarinate; nuchals and scales immediately following nuchals have four to six keels; the crease of the axilla with five or six rows of minute granules not forming a "pocket" or at most only a very shallow one; in crease behind insertion of thigh a similar series of five or six rows of granular scales. Scales on arm tricarinate and either bi- or tricarinate on upper surfaces of thigh and tibia; a pair of distinctively enlarged preanals with three other smaller preanals on each side; temporal scales keeled.

Tubercular scales on palm and soles somewhat pyramidal; subdigital lamellae rounded, nearly smooth without keel, 15-16 under fourth toe. Swollen area on posterior part of thighs covered with a series of irregular enlarged scales with narrowed tips that stand nearly erect and are separated from each other; the scales above and below them are regularly imbricating scales. Adpressed hind limb reaches to elbow of adpressed arm.

Color. Above dull olive with metallic reflections; a greenish white dorsolateral line runs from eye to base of tail becoming less distinct as tail is approached; a broad brownish band follows along side from eye to groin; an indistinct line on supralabials becomes distinct behind eye, and gives a whitish border to ear opening and beyond which it may be traced below the brown band to groin. Top of head brownish; two series of about twenty short narrow transverse black marks beginning at shoulder continue back to some distance on tail. Ventral surface light with a slight greenish cast.

Measurements in mm. of the type and paratype respectively. Snout to vent, 56, 55; tail length, 95, (?); length of head to end of interparietal, 10, 9.9; width of head at ear, 9.5, 9.6; snout to ear opening, 11.7, 11; snout to foreleg, 20, 20; axilla to groin, 27, 28; foreleg, 14, 14.5; hind leg, 21, 21.5.

Variation. The paratype agrees with the type in all characters listed except there is less evidence of an outer keel in the smooth space between the series of three keels, and the small dorsal marks are reduced to two dots instead of a single narrow transverse mark. These double series occur from shoulder to some distance on the tail.

Remarks. This species was found in a coconut grove some distance back from the sea beach and was never observed climbing.

The modified scales on the posterior part of the thigh is a character that has not been used by Boulenger or Smith in separating the Asiatic species of *Mabuya* but it is apparently constant in the species in which it occurs*. This condition is reminiscent of a scale modification that occurs on the posterior part of the thighs of certain eastern Asiatic *Eumeces*.

The looseness of these scales allows the ingress of numerous small mites, and both specimens show infestations of these parasites.

Mabuya carinata (Schneider)

Scincus carinatus (part) Schneider, Historia Amphibiorum, vol. 2, 1801, p. 183 (type locality unknown).

Mabuia carinata Boulenger. Catalogue of the Lizards in the British Museum, 2d ed., vol. 3, 1887, pp. 182-183 (Ceylon); Fauna of British India including India and Ceylon: Reptilia and Batrachia, 1890, pp. 188-189, fig. 56 (Ceylon). Willey, Spolia Zeylanica, vol. 4, 1907, pp. 186-188. Green, *ibid.*, vol. 5, pt. 18, Apr., 1908, p. 104 (presumed poisonous bite). Deraniyagala, Ceylon Journ. Sci., sec. B, vol. 16, 1931, p. 167.

Mabuya carinata Smith, The Fauna of British India including Ceylon and Burma; Reptilia and Amphibia, vol. 2, Sauria, Feb. 7, 1935, pp. 206-207, fig. 68.

Tiliqua rufescens (part) Günther, The Reptiles of British India, 1864, pp. 79-80 (Ceylon).

This large species is represented in the collections by U. S. N. M. No. 120325 from Clodagh Estate, Rattota, Matale District, collected by H. G. Deignan; and EHT-HMS Nos. 30504-30505, 30489, 30493 collected 12 mi. N of Trincomalee, Ceylon, by E. H. Taylor. The specimens are typical. This species has a range extending throughout Ceylon, and it is widespread in India and Burma.

The species may be recognized by the following characters: supranasals separate; frontonasal longer than broad; prefrontals separate (elsewhere they may be in contact); a pair of nuchals; no postnasal; anterior loreal higher, but shorter, than second (the two fused in No. 30490); three or four large scales on lower eyelid; postmental usually touches a single median scale, thus separating the first pair of chinshields; dorsal scales subequal, 30 scale rows around body (30-34 reported elsewhere); the temporals keeled; scales keeled with three (young), five or, rarely, seven keels on dorsum and side of adults; ventrals smooth; 15 to 18 smooth lamellae under fourth toe. Reaches a length of 125 mm. snout to vent. Olive above, uniform or with flecks or lines on the scale edges. The dorsolateral light stripe from eye to tail often orange or reddish in males during the breeding season.

* It is possible that the variation is not fully evident in young specimens as suggested under *Mabuya macularia* Blyth (this paper).

Mabuya madarászi Méhely

Mabuia madarászi Méhely, Termes. Füzetek, vol. 20, 1897, pp. 59, 61 (type locality, Kala-Wewa and Madatugama, Ceylon).

Mabuia macularia (part) Smith, The Fauna of British India including Ceylon and Burma, Reptilia and Amphibia, vol. 2, Sauria, Feb. 7, 1935, pp. 264-266.

The distinctive modification of the squamation on the posterior part of the thigh of this form caused me to believe at first that the series here reported constituted a new form. However since the specimens agree with the type description of *Mabuya madarászi* in other characters, I suspect that the thigh characters were overlooked by Méhely, as well as others who have seen Méhely's types, or other specimens of this species from Ceylon.

The larger part of the specimens have heavy infestations of a small mite on the back of the thigh that tends to distort the appearance of the area. However when the mites are removed the characters are distinct. Some of the specimens have no such infestations, and the scales are modified in the same manner.

I append a rather detailed description of a specimen to supplement the original type description.

Diagnosis. A medium-sized, arboreal *Mabuya,* five- to seven-keeled; transparent part of eyelid broken up into at least five quadrangular scales; supranasals separated; prefrontals and parietals also separated; five superciliaries; no postnasals; two or three primary temporals; subcaudals not widened; chinshields broadly in contact; an irregular series of scales covering a somewhat swollen area on posterior thigh surface; posterior to insertion of leg, an area of smaller irregular scales, and in the distal end of femoral region another area of smaller scales, the two areas connected by a double or triple series of large, somewhat irregular loosely imbricating scales.

Description of EHT-HMS No. 30566. Portion of rostral visible from above nearly two thirds of length of frontonasal, the two scales forming a suture that separates the narrow elongate internasals; frontonasal distinctly wider than long, touching anterior loreals laterally and frontal posteriorly, thus separating prefrontals; frontal elongate touching only second supraocular, which is also in contact with prefrontal; interparietals a little more than half length of frontal; interparietal definitely longer than wide; nuchals and part of parietals destroyed; nasal small, the part behind nostril greatly reduced; anterior loreal much higher but less than half as wide as posterior loreal; two presuboculars; height of subocular in its length, 2½ times; four supralabials anterior to subocular; four supraoculars;

five superciliaries; four postsuboculars diminishing in size; two primary temporals, three secondary temporals; mental almost equal in length to postmental; first pair of chinshields in contact, second pair separated by one scale, third pair by parts of three scales; eight infralabials; three or four small ear lobules; diameter of circular ear opening half length of subocular; lower eyelid with a semitransparent area covered by five or more vertically elongated quadrangular scales.

Thirty scale rows around middle of body, the twenty dorsal and lateral rows are seven-keeled (sometimes five in young); a varied number (two to five) of keels on upper side of arm and leg; usually three or more keels present on basal third of tail; scales following nuchals somewhat irregular.

Limbs long, the adpressed hind limb reaching to axilla; lamellae under fingers and toes not or bluntly keeled; 15-15 lamellae under fourth toe; two median preanals distinctly larger than surrounding scales, the three lateral preanals diminishing in size; subcaudals not distinctly widened. Scales on back of thigh strongly modified; a group of small scales behind insertion and another group of smaller scales at distal end of femoral region; the scales between these areas soft, more or less pointed, loosely imbricated, often nearly erect.

Color in life. Upper surface of head coppery brown, the eight dorsal scale rows copper colored with some olive wash and metallic reflections, and with some trace of darker markings in the middle of each scale suggesting indistinct darker lines; an indistinct dorsolateral light line continues some distance on tail; a broad dark brown band begins behind eye and continues far on tail, laterally occupying two whole rows and parts of two other scale rows. A cream line beginning on upper labials passes below ear, bordering the brown band below and continuing some distance on the tail; ventral surface washed lightly with dull olive.

Measurements in mm. Snout to vent, 72; tail, 99, partly regenerated; width of head at ear, 11.2; length of head to end of interparietal, 12.5; snout to ear, 15; snout to arm insertion, 27.5; axilla to groin, 35.5; arm, 21.5; leg, 35.2.

Variation. As regards the diagnostic scale characters, there is little or no significant variation. The coloration, however, does vary.

No. 30570. This specimen has eight dorsal scale rows and the top of the head is bright copper with metallic reflections. The borders of the brown band above and below were greenish cream in life. Nos. 30505 and 30571 have this identical coloration although they

differ much in size (respectively 72, 63, and 51 mm. in snout-to-vent length). One of the specimens (30568) has the median dark areas in the scales somewhat intensified and there are five narrow dark dorsal lines evident when the specimen is submerged. Scale rows vary between 30 and 32; only one has the latter count, and three have 31. The others have 30 rows.

Two adult female specimens (30569, 30572) differ in having the scales in the nuchal and temporal regions dimly keeled or smooth, and the specialized scales on the posterior part of the thigh are more definitely pointed and soft; the hind legs fail to reach quite to the axilla. One female is strongly infested with small mites in the post-femoral region.

The lamellae under the fourth toe vary between 15 and 18, 16 being most frequent. The number 18 was encountered once, 15 three times. In none of the specimens is there a trace of ocellated spots on the sides of the neck and body.

Remarks. It seems probable that this species has been confused with another or other species of which *macularia* is the most probable. The latter species has been reported and certainly occurs in Ceylon. A Ceylon specimen is fortunately at hand and a description is given.

GENUS RIOPA Gray

Riopa Gray, Ann. Mag. Nat. Hist., vol. 2, Jan., 1939, p. 332.

Genotype. Lygosoma punctatum.

Two species occur on Ceylon: *Riopa punctata* and a new form here described, *Riopa singha.*

KEY TO THE SPECIES OF RIOPA IN CEYLON

Scales 24-26 rows, each dorsal and lateral scale with a dark spot. In young spots forming 6 dark lines separated by light lines; tail uniform red; dorsolateral light lines from rostral..... *Riopa punctata*

Scales in 28 rows; four very narrow dark lines on median scale rows; dorsolateral lines from supraoculars; vertical rows of white spots on neck and scattered white spots on the sides; a dorsolateral line from nuchal..... *Riopa singha*

Riopa punctata (Linne)

Fig. 1

?Lacerta punctata Linne, Syst. Nat., 1, p. 369.

Scincus punctatus Gmelin, Hist. Amphib., 1799, p. 197, based on Seba's fig. 2, pl. 12, fig. 6.

Riopa punctata Smith, Fauna of British India including Ceylon and Burma, Reptilia and Amphibia, vol. 2, Sauria, 1935, pp. 318-319.

U. S. N. M. No. 29412, "Ceylon"; EHT-HMS Nos. 30174-30181, 12 miles north of Trincomalee, Ceylon; E. H. Taylor, coll.

The series from near Trincomalee on the northwest coast, for the most part, was found in coconut groves near the seashore. Indi-

viduals were secretive and their presence was usually made known by the flash of the bright red tail. This red is present on the tails of all young and half-grown specimens, but tends to become completely obsolete in adult animals.

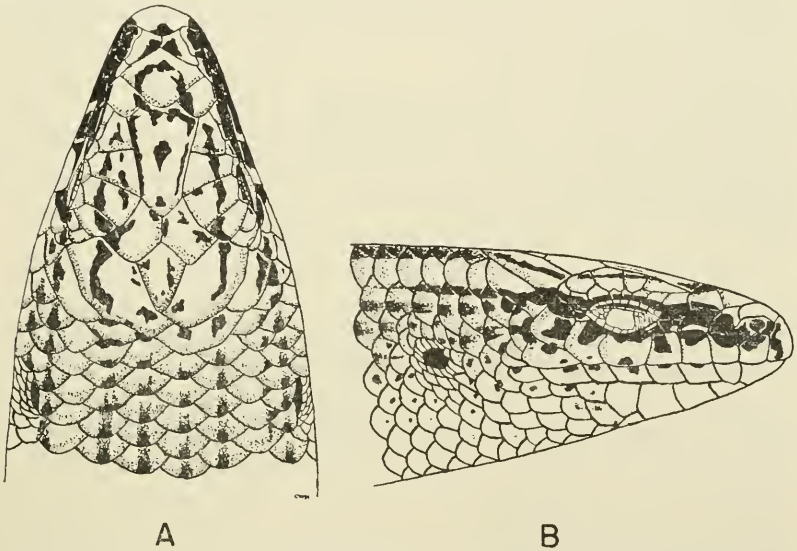

FIG. 1. *Riopa punctata* (Linne). EHT-HMS No. 30178, 12 mi. N Trincomalee, Ceylon. A. Head, dorsal view. B. Head, lateral view. × 6.

The color markings are strongly delineated. Two dorsolateral cream lines begin on the tip of the snout and continue to the tail where they become lost, the intervening dorsal ground color being light olive-tan with six longitudinal series of black spots, one spot on each scale. Seven lateral rows of scales likewise bear black spots. The three upper rows are composed of larger spots and together suggest a dark lateral band or stripe. The ventral scale rows, chin and throat are immaculate. In the young the tail, save in the basal region, is unspotted and of a uniform shade of red. As they grow older, the caudal scales develop small spots (even those on the ventral surface) and gradually the red (sometimes pink) coloration disappears. In the young the black spots are contiguous forming continuous lines. On the head the dots are carried forward to the snout but later tend to form a more or less symmetrical pattern on the head scales.

Scale counts about midbody are 24 to 26; however, when the count is made a little farther forward sometimes 28 may be found. The reason for the variation is that the axillary rows (32 about

body in axilla) tend to drop out quickly but one or two rows on each side may continue back to near midbody. The scales in a row from the nuchal to a point above anus number 68 to 76; the scales under the tail to tip, number 90-91 (2 counts). In all, the prefrontals are separated and the internasals are in contact (barely contiguous in one specimen).

U. S. N. M. No. 29412 is an old faded specimen agreeing with the described series in all pertinent details.

In the figured specimen a small postnasal is evident. This occurs in none of the other specimens, and is absent on the left side in the specimen figured. I regard its presence as anomalous.

Riopa singha, sp. nov.

Fig. 2

Type. U. S. N. M. No. 29411, "Ceylon"; D. L. Karcher, coll.

Diagnosis. A species related to *Riopa albopunctatum;* four very narrow dorsal lines on middle of back; wide dorsolateral cream lines begin at supraoculars; below dorsolateral light line an irregular dark stripe not of solid color, widest at neck and above arm and axillary region tending to form four, fine, broken, dark lines posteriorly. On this dark stripe vertical series of white dots alternating with darker spots, these often somewhat irregular. Scale rows around body, 28; a transparent eye disk present; 70 scales on back between nuchals and a point above vent; snout to arm insertion length contained in axilla to groin length 2½ times; adpressed limbs separated by a distance equal to one and a half to one and two thirds length of arm.

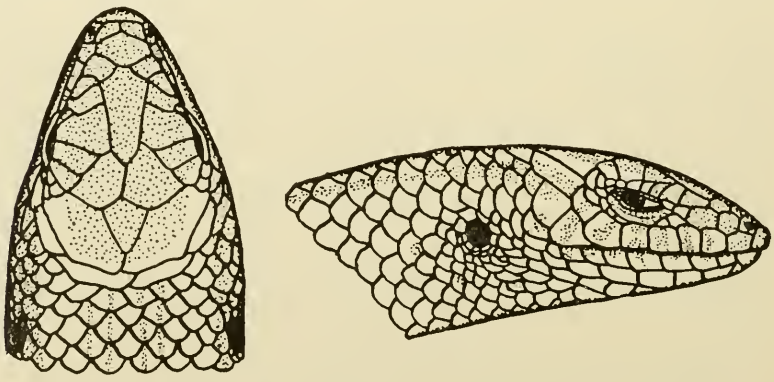

FIG. 2. *Riopa singha* sp. nov. U. S. Nat. Mus. No. 29411, Type. A. Head, dorsal view. B. Head, lateral view. × 5.

Description of the type. Rostral separated from frontonasal by paired supranasals; frontonasal broader than long, forming suture with frontal; prefrontals rather small, separated; frontal elongate, longer than distance to snout but about two mm. shorter than parietals, interparietal and frontoparietals together; parietals broadly in contact behind interparietal, and bordered by a large temporal and a pair of narrow nuchals; four supraoculars; eight superciliaries; nostril in a small nasal; no postnasal; two loreals, anterior higher than wide, higher but shorter than second which is nearly square; seven upper labials, the suboculars not elongated; two primary temporals, two or three secondaries, upper scales small; the lower secondary separated from ear by four scale rows; seven lower labials; mental followed by a large postmental and this followed by three paired chinshields, first pair in contact, second pair separated by one scale, third pair by five scales; 28 scale rows about middle of body; about 36 rows around body at axilla; 72 scales from parietal to above vent; limbs short, when adpressed, separated by 18 scales; 14 lamellae under fourth toe, strongly keeled; ear opening large, about one third of eye opening; one large and one small auricular lobule; eyelid with a more or less transparent disk; six preanals all somewhat enlarged; tail regenerated; distance from snout to insertion of arm contained in axilla to groin distance 2½ times.

Color. The specimen is of a dirty olive color and probably shows none of the original coloration. A dorsolateral light line two and one half scales wide begins on supraoculars and passes back onto tail; the four median dorsal scale rows with hair-fine brownish lines along their middle; a broad lateral black or brown stripe, tending to form three fine lines posteriorly, and anteriorly with round light spots sometimes forming vertical rows on sides of neck; below uniformly unspotted; limbs with brown spots above.

Measurements in mm. Snout to vent, 44; snout to forelimb, 11.4; axilla to groin, 29; arm, 6.5; leg, 11.

Remarks. The type is in a good state of preservation save that the abdomen has been opened widely, and one limb broken. It is a female as evidenced by several ovarian eggs. The tail shows at least two different regenerations. There is a possibility that this form is the representative of *Riopa albopunctatum* on Ceylon. The points that appear to separate the species are the different body proportion (snout to arm contained in axilla to groin 2½ times, and the limbs separated by a distance equal to one and one half times the

length of the arm) and some differences in color and markings (fine dark lines on four medial scale rows, the wide dorsolateral light line one and one half scale rows wide).

The actual extent of differentiation between the two forms can be determined only with more material from Ceylon and a study of the Indian specimens of *R. albopunctata* with a view of determining geographical trends in squamation.

GENUS DASIA Gray

Dasia Gray, Ann. Mag. Nat. Hist., vol. 2, 1839, p. 331.

Genotype. Dasia olivacea.

A single endemic species is known from Ceylon.

Dasia haliana (Haly and Nevill)

Euprepes halianus Haly and Nevill, Taprobanian, vol. 2, 1887, p. 56 (type locality Henaratgoda and Anuradhapura, Ceylon); Boulenger, Fauna British India, including Ceylon and Burma; Reptilia and Batrachia, 1890, p. 213 ("probably belongs to Lygosoma"); Haly, Ceylon Admins. Rept., 1893, p. 13.

Theconyx halianus Annandale, Spolia Zeylanica, vol. 3, 1906, p. 191, figs. 1-4.

Lygosoma (Keneuxia) halianus Deraniyagala, Ceylon Journ. Sci., sec. B, vol. 15, 1931, p. 174, pl. 37.

Dasia haliana Smith, Fauna British India, including Ceylon and Burma; Reptilia and Amphibia, vol. 2, Sauria, 1935, pp. 278-279.

This arboreal species is known from Central Province, North Central Province, Southern Province, Western Province and Northern Province. It may readily be distinguished from other scincoid species by the following characters: supranasals present; the nostril in a single nasal; the prefrontals, interparietal, and frontoparietal distinct; the ear opening small; large, well-developed clinging limbs; and a yellow-olive color with five or six broad transverse black bands. No specimens are present in the collections.

GENUS SPHENOMORPHUS Fitzinger

Sphenomorphus Fitzinger, Systema Reptilium, 1843, p. 23.

Genotype. Lygosoma melanopogon.

Seven species from Ceylon are referred to this genus.

KEY TO THE SPECIES OF SPHENOMORPHUS IN CEYLON

1. Frontoparietal divided 2
   Frontoparietal single 6
2. Less than thirty scale rows about body 3
   Forty scale rows about body ..... *dussumieri*
3. Parietals enclosing interparietal 4
   Parietals separated by interparietal ..... *megalops*
4. Dorsal scales striated ..... *deignani*
   Dorsal scales unstriated 5
5. Adpressed limbs barely overlap, prefrontals forming a common suture ... *taprobanense*
   Adpressed limbs separated by seven scales; prefrontals usually separated, *striatopunctatus*
6. Males with side of head and throat blue-black, each scale with a whitish spot .. *fallax*
   Males with throat bright rosy red, lacking black color and white spots ..... *rufogulus*

Sphenomorphus dussumieri (Duméril and Bibron)

Lygosoma dussumieri Duméril and Bibron, Érpetologie Générale . . . vol. 5, 1839, p. 725 (type locality, Malabar, India).

Lygosoma (Sphenomorphus) dussumieri Deraniyagala, Ceylon Journ. Sci., sec. B, vol. 16, 1931, p. 169.

This species has been recorded by Deraniyagala from Peradeniya, Ceylon. It also has a considerable range in southwestern India, and in certain areas it is very common. It may be differentiated from the other species of the genus by the following characters:

The distance between the snout and the forelimb is equal to, or a little less than the axilla-to-groin distance; the prefrontals are broadly in contact; and four or five supraoculars are present. There are 40 scale rows around the middle of the body, the dorsal scales being striated; 20-25 lamellae are present under the fourth toe.

Sphenomorphus megalops (Annandale)

Lygosoma megalops Annandale, Spolia Zeylanica, vol. 3, 1906, p. 190 (type locality, Puttalam and Kitulgala, Ceylon); Smith, Fauna of British India, etc., Reptilia and Amphibia, vol. 2, 1935, p. 289.

The following characters differentiate this species. The types are said to be lost and no other specimens are known to be in collections.

The length from the snout to the forelimb is contained one and one half times in the axilla to groin length. The limbs overlap when adpressed. The eye is large, its diameter as long as the snout. There are no auricular lobules or denticulations on edge of ear. There are no supranasals present, and the parietals are separated by the interparietal. The dorsals and lateral scales are smooth but the ventral scales are feebly keeled. These are arranged in twenty-four to twenty-six scale rows about the body. The color is uniform dark brown. The length of body of the type is two inches and of the tail, two and three eighths inches.

Sphenomorphus deignani, sp. nov.

Fig. 3

Type. U. S. N. M. No. 120326, collected on Mount Ganoruwa (Gangarowa?) Peradeniya, Kandy District, Central Province, Ceylon, by Herbert G. Deignan, 1944.

Diagnosis. A medium-sized, pentadactyl skink, characterized by short limbs, the toes barely overlapping when adpressed; ear-opening large, the tympanum deeply sunk; paired frontoparietals, prefrontals broadly in contact; dorsal scales each with two striae;

nuchals lacking; 24 scales about body; numerous lateral scales with white spots; jaws strongly barred with black.

Description of type. Rostral seen from above little more than half width of frontonasal and forming a rather straight transverse suture with latter; no supranasals; prefrontals large, broadly in contact; frontal a little shorter than combined length of fronto-

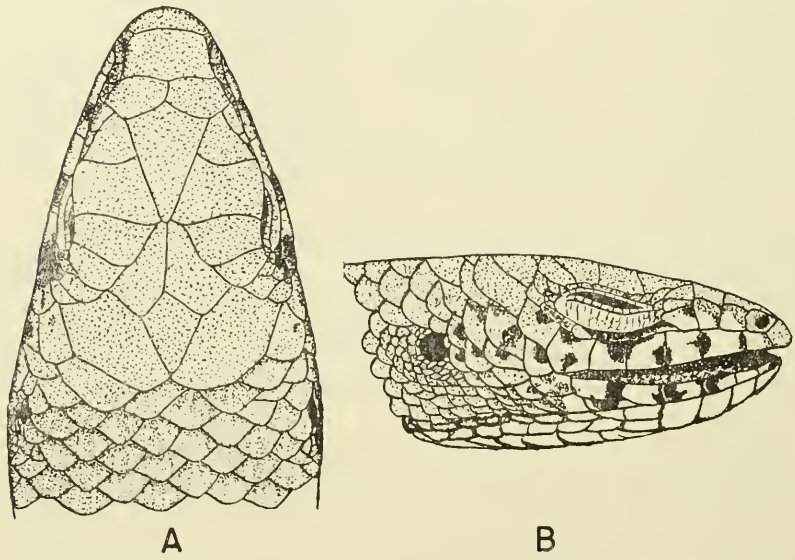

FIG. 3. *Sphenomorphus deignani* sp. nov. U. S. Nat. Mus. No. 120326, Type. A. Head, dorsal view. B. Head, lateral view. × 5.

parietals and interparietal; four large supraoculars; frontoparietals two; parietals inclosing interparietal; enlarged nuchals lacking; each parietal bordered behind by an enlarged temporal; nine superciliaries; nostril in a single nasal; two loreals of nearly equal size and height; two preoculars, the upper small; suboculars eight or ten, forming a well-defined row along the lower edge of eyelid; eyelid covered with small scales; diameter of eye equal to its distance from nostril; a single primary temporal, not touching the parietal, followed by a pair of secondary temporals, the lower of which is separated from ear by three scale rows; seven upper labials; five lower labials; the mental rather shortened but as wide as rostral, one third as long as postmental; first pair of chinshields in contact; second pair, separated by a scale, touching labials; third pair separated from each other and the labials.

Ear-opening about one fourth of eye diameter, with one or two minute thin lobules on its anterior border.

Twenty-nine scale rows around constricted part of neck; 34 about body behind arm; 28 rows of subequal scales about middle of body; median preanal scales somewhat enlarged; median subcaudals not widened; 48 scales on back from parietals to point above vent. Dorsal and lateral scales with distinct striations, three striae on scales on nape, two striae on most of the other scales; ventral scales smooth; striae present on ventral, lateral, and dorsal scales of tail, but body ventrals have them barely indicated; greater part of tail missing.

Limbs short; the arm reaches forward to eye; hind limb overlaps the adpressed arm by half length of third finger; nineteen to twenty lamellae under fourth toe.

Color and markings. Above dark olive brown, growing light brown on back of body and base of tail; below on chin, abdomen, and under side of tail creamy white; a series of vertical black spots or lines on jaws and on temporal region; sides of base of tail with a few black flecks; heavy black reticulation with whitish spots on arms and legs. Under a lens each scale of back and sides with a crenellated, curved, black spot; together the spots form a complete reticulation, especially evident when epidermis is shed. Many lateral scales have minute, greenish white flecks.

Measurements in mm. Snout to vent, 55; tip of snout to ear, 12; tip of snout to arm insertion, 20; axilla to groin, 28; arm length, 12; leg length, 16.

Comments. The described species may be separated from the other related Ceylonese and Indian species of *Sphenomorphus* as follows: From *megalops* by the smooth instead of the keeled ventrals, seven instead of six upper labials, the presence of striae on the scales, and the different coloration; from *fallax* and *rufogulus* by the paired, rather than single, frontoparietal. From *striatopunctatus* it differs in having the prefrontals broadly in contact instead of widely separated, the limbs touching instead of being separated considerably when limbs are adpressed, toes longer, the lamellae under fourth toe nineteen to twenty instead of ten to twelve, and the markings are different. From *taprobanense,* the present form differs in coloration and markings, heavier and proportionally longer limbs with more numerous scales on feet and palms, and in the presence of striae on the scales. It is a much heavier species. The type of *taprobanense* was said to have six lines of

black dots on the back, the sides of neck and body of a darker brown minutely dotted with white.

The species is named for Dr. Herbert G. Deignan of the U. S. National Museum, who collected the type of the species.

Sphenomorphus taprobanense (Kelaart)

Eumeces taprobanense Kelaart, Prodromus Faunae Zeylanicae, vol. 2, pt. 1, 1854, p. 21 (type locality, Newera Ellia [= Nuwara Eliya], Ceylon); Günther, Reptiles of British India, 1864, p. 89 (part. but not figure).

Lygosoma taprobanense Boulenger, Catalogue of the Lizards of the British Museum, vol. 3, 1887, p. 319; and Fauna British India, Reptilia and Amphibia, 1890, p. 206; Smith, Fauna British India . . ., Reptilia and Amphibia, vol. 2, Sauria, 1935, pp. 287-288.

Lygosoma (Sphenomorphus) taprobanensis Deraniyagala, Ceylon Journ. Sci., sec. B, vol. 16, 1931, p. 120.

This form, of which I have no specimens available, may be distinguished by the following characters: The distance between the end of the snout and the foreleg is contained in axilla to groin distance one and one third to one and three fifths times. The prefrontals are in contact or separated. There are two subequal loreals present. The ear opening is about one half the size of the eye opening. The body scales are smooth, arranged in 24-26 scale rows about the middle. The limbs just meet or narrowly fail to meet when adpressed. The color is brown above with six dark longitudinal lines formed by dots. The upper half of the flank and neck are dark brown, while the color of the lower margin is not well defined. The sides of the neck are with or without white spots. The ventral surface is whitish save that the throat of the adult male is dark blue or purple. The snout-to-vent measurement is 58 mm.

The species is found in the mountainous regions of the central and southern parts of Ceylon.

Sphenomorphus striatopunctatus (Ahl)

Lygosoma punctatolineatum (not of Boulenger, 1893) Boulenger, Spolia Zeylanica, vol. 4, 1907, p. 173 (type locality, Hakgalla, Ceylon).

Lygosoma (Sphenomorphus) punctatolineolatus Deraniyagala, Ceylon Journ. Sci., sec. B, vol. 16, 1931, p. 169.

Lygosoma striatopunctatum Ahl, Zool. Anz., vol. 6, 1925, 1 and 2, p. 20; Smith, Fauna British India, including Ceylon and Burma; Reptilia and Amphibia, vol. 2, Sauria, 1935, p. 288.

The species here described agrees with the form *striatopunctatus* in practically all characters save that the prefrontals are moderately large and in contact. The following description is from a Ceylon specimen, No. 120327, in the U. S. National Museum, which, with No. 120326, was collected by Dr. H. G. Deignan, Mount Ganoruwa, Peradeniya, Kandy District, Ceylon.

Distance between end of snout and forelimb (15 mm.) contained in axilla to groin distance (21 mm.) 1.4 times; snout moderately long, oval; rostral convex, broadly in contact with frontonasal,

which is broader than long; prefrontals in contact (said to be rarely separated); frontal as long as frontoparietals and interparietal together; parietals large forming a suture behind interparietal; two frontoparietals; no nuchals; four large supraoculars, the last bordered by two small scales; second largest, first and second touch the frontal; eight or nine superciliaries; a large primary temporal followed by two large secondary temporals, these bordered behind by three smaller scales; seven upper labials, the fifth below eye; presuboculars, suboculars and postsuboculars forming a continuous series of eight or nine scales, all dark colored; two loreals, second largest; nasal single; no postnasal; mental followed by an undivided postmental and two pairs of large chinshields that border labials but only first pair in contact; third pair rather large, separated from labials by an elongate scale; diameter of ear opening about one third that of eye, with one or two projecting lobules; tympanum deeply sunk; body scales smooth; 26 scale rows about middle of body; 53 scales from parietals to above vent; tail somewhat thickened at the base, definitely quadrangular in cross-section; tail partly regenerated, the ventral scales being enlarged on regenerated part (normal scales small); limbs when adpressed separated by about seven scales; thirteen lamellae under the fourth toe; palms and soles with flattened, rather than conical, scales.

The color is as follows (male): Entire head bluish black without white spots, gradually becoming brown on neck; brown on body, with indicated lines (many dorsal scales missing); slightly darker on upper sides, many of the dark scales having a light spot or fleck; lower scale rows on sides dirty white, as are the ventral abdominal scales; tail colored like body, unspotted below.

Snout to vent, 40 mm.; arm, 7 mm.; leg, 11 mm.; axilla to groin, 21 mm.; snout to foreleg, 15 mm.; width of head, 5.6 mm.; head length to back of parietal, 8 mm.

Sphenomorphus fallax Peters

Fig. 4

Lygosoma fallax Peters, Mon. Berlin Akad., 1860, p. 184 (type locality, "Ratnapura, Trincomali" Ceylon); Boulenger, Catalogue of the Lizards of the British Museum (Natural History), vol. 3, 1887, p. 320 (part); Fauna of British India, Reptilia and Batrachia, 1890, p. 206; Méhely, Termes. Füzetek, vol. 20, 1897, p. 61 (Kala Wewa, Ceylon); Smith, Fauna of British India including Ceylon and Burma, Reptilia and Amphibia, vol. 2, Sauria, 1935, pp. 288-289.

Lygosoma (Sphenomorphus) fallax Deraniyagala, Ceylon Journ. Sci., sec. B, vol. 16, 1931, p. 172.

Eumeces taprobanensis (part) Günther, Reptiles of British India, 1864, p. 89 (not figure).

The following specimens are in the collections: U. S. N. M. Nos. 27286, 29413, "Ceylon," and EHT-HMS Nos. 13082-13093, 23 miles west of Trincomalee, Ceylon.

This small species is easily distinguished from *Sphenomorphus striatopunctatus, S. taprobanense, S. megalops, S. dussumieri* and *S. deignani* by having the frontoparietals fused together to form a single scale. It is not entirely easy to distinguish from *S. rufogulus,* a species described herein, that likewise has the frontoparietal single. The males of *fallax* may be distinguished easily since *fallax* has a blue-black head, and cream-white dots on the side of head and throat; and *rufogulus* has a large red area on the throat and no trace of the blue-black coloring on the head. However, females lack these characters and the slight scale differences and the absence of well-defined color patterns make them difficult to distinguish. Twelve miles north of Trincomalee, *rufogulus* was found

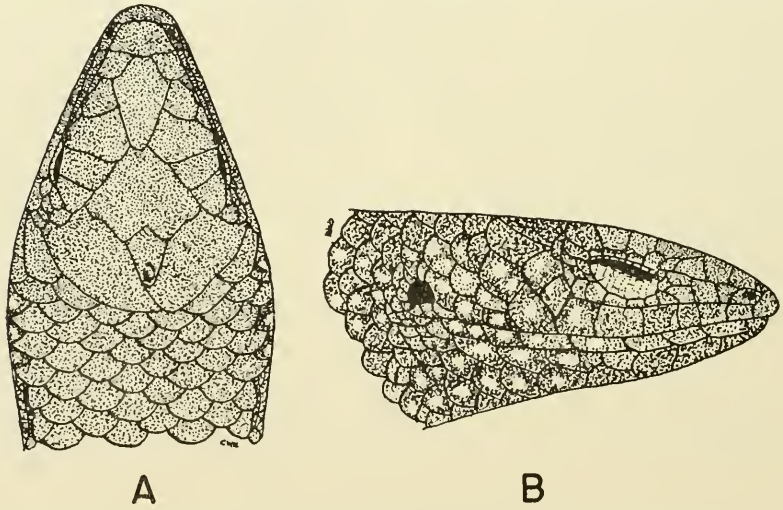

FIG. 4. *Sphenomorphus fallax* (Peters), EHT-HMS No. 13084, 20 mi. W Trincomalee, Ceylon. Male. A. Head, dorsal view. B. Head, lateral view. × 5.

alone and there it was a very common species in the forest near the seashore. Twenty miles from Trincomalee to the west it was found in the forest with *fallax,* the latter apparently in the greater numbers. A very large number of specimens of both species might very readily have been taken had I so desired, as they seemed to be everywhere on the forest floor.

Eight specimens of *S. fallax* have the prefrontals forming sutures of varying width, seven have them separated by variable distances. None have true nuchals, the parietals being bordered by a temporal and five or six body scales. In several specimens the two outer body scales fuse to make a larger scale following the temporal, and re-

MEASUREMENTS AND SCALE COUNTS OF *Sphenomorphus fallax*

Number	Sex	Snout-vent length	Tail length	Width of head	Snout tip to arm	Axilla to groin	Arm	Leg	Scales about body	Scales to above vent	Lamellae on fourth toe	Anterior temporals
30194	♀	41.5	53	6	15	22	7.2	10.5	26	52	15–15	2
30189	♂	41.5	..	6.4	15.5	22.4	9	12	26	51	16– 0	2
29413	♂	41.5	..	7	14.8	23	7	11.5	26	51	15–15	2
30184	♂	41.3	..	6.4	14.6	22.3	8	12	28	52	15–16	2
30182	♀	41	57	5.9	13	23	7	10.5	26	53	15–16	1
30190	♀	41	..	5.8	13.5	23	8.1	11.2	26	52	15–16	2
30192	♂	40.2	..	6.2	15	21.5	8.2	12.3	28	50	15– 0	2
30191	♂	40	..	6.3	16	23.5	8.2	12.2	26	51	18–18	1–2
30188	♂	40	..	6.2	13.8	21.5	8.1	12	26	52	15–14	2
30193	♂	40	..	6.1	14.2	22.3	7.2	12	26	53	15–16	1
30186	♀	39	56	5.7	14	22	7.5	11	26	52	16–17	2
30183	♀	38	57	6	12	21	6.5	10.2	28	53	15–15	2
27286	♂	37.5	..	5.8	14	22	7.5	11.8	26	50	15–16	2
30185	♀	37	54	5.5	12.2	22	6	10	26	51	13–15	2

ducing the number of scales to three or four. The frontal is usually rather small (2.5 mm. in length) while the combined frontoparietal, interparietal and the parietal length measures 4.15 mm. on the median line. The scales of the third pair of chinshields are separated from each other by a single scale and from the labials by a single scale. The presubocular, subocular and postsubocular series are continuous, large, and heavily pigmented like the lateral head scales.

The coloration in the males is deep, almost uniform brown on the ten median dorsal scale rows, with little or no trace of pattern visible under the lens; no dorsolateral lighter line is visible. The three lateral scale rows each show a very slight suggestion of three light lines, often scarcely traceable. The underside of the body is immaculate. The sides of the head, and throat, are bluish black, the color extending to behind the ear opening, each scale with a whitish or bluish white spot more or less clearly defined. The top of the head is variable, dark or lighter brown. The blue-black coloration is missing on head and throat in the females but the lateral whitish lines from axilla to groin are rather clearly distinguishable, the upper being most distinct. A distinct dorsolateral line two half scales wide is present, below which there is a distinct dark band, one whole and two half scale rows wide. Some of the cheek scales and labials may show lighter areas. The sides and ventral part of the tail are more or less heavily flecked with dark brown.

Further data on this series of specimens is given in the following table. Measurements indicate a relatively small amount of size variation other than that dependent on sexual variation. This is evident in the wider head in the males and the somewhat slenderer bodies in the females. None of the males have complete tails.

Sphenomorphus rufogulus sp. nov.

Fig. 5

Type. EHT-HMS No. 30229 collected 12 mi. N of Trincomalee, Ceylon, Sept. 1944, E. H. Taylor, collector.

Paratypes. EHT-HMS Nos. 30195-30228, 12 mi. north of Trincomalee, Ceylon, Sept., 1944; Nos. 30230-30233, 21 mi. east of Trincomalee, Ceylon, Sept., 1944, E. H. Taylor coll.

Diagnosis. A small species of the size of *Sphenomorphus fallax*, and, like it, having the frontoparietals fused, the interparietal and the internasals enclosed by the parietal, two or three primary temporals, but differing in having the throat and chin lacking dark

pigment, and colored bright red in the males. Males with three to five dim ocelli on the last supralabials and temporals. Dorsal coloration lighter brown.

Description of the type. Rostral broad, low, two and one half times as wide as high; frontonasal one and one half times as broad as long; prefrontals large, forming a broad suture; frontal longer than its distance from end of snout, a little shorter than frontoparietal; width of frontal contained in width of supraoculars one and one fourth times; frontoparietal a single scale, its length minutely less than its width; interparietal small, enclosed by large parietals;

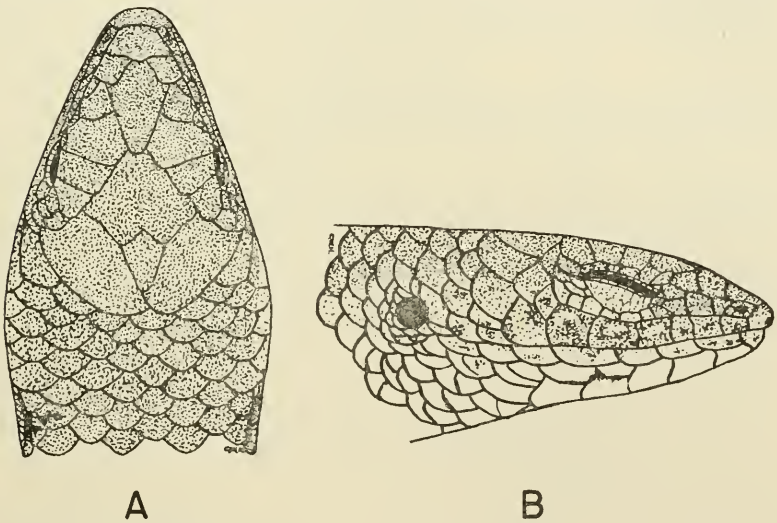

FIG. 5. *Sphenomorphus rufogulus* sp. nov. EHT-HMS No. 30228, Paratype and topotype. A. Head, dorsal view. B. Head, lateral view.

combined length of parietals and frontoparietal exceeds their distance from the snout tip about one eighth; nostril in a single nasal followed by an anterior loreal wider at top, higher but narrower than posterior loreal; a pair of preoculars, the lower larger; seven or eight superciliaries; four supraoculars, two touching frontal; seven supralabials, the fifth below middle of eye; a series of six scales lie between labials and small scales of eyelids; a rather large scale partly between fourth supraocular and parietal; one rather large postocular; three primary temporals, the upper largest; two secondary temporals, the lower separated from ear by two scales; mental more than half as wide as postmental; three pairs of chinshields, first pair in contact, second separated by a scale but touching

MEASUREMENTS AND SCALE COUNTS OF *Sphenomorphus rufogulus* sp. nov.

Number	Sex	Length to vent	Tail	Width of head	Snout to arm	Axilla to groin	Arm	Leg	Scale rows	Dorsal scales to above vent	Lamellae under fourth toe	Anterior temporals
30228	♂	42.5	..	6	13.3	24	8	12	26	51	17–15	1–2
30212	♀	42	regen	5.5	13.5	22	8	10.5	26	..	15–16	1–2
30199	♀	41	..	5.9	13	23	7.8	11	26	53	15–18	2–1
30201	♀	40	60.8	5.3	12.8	22	7.6	10.5	26	52	16–18	2–2
30209	♀	39	61	5.3	13	21	7.2	10.8	26	54	18–16	2–2
30196	♂	39	regen	6.1	14	21	7.8	12.1	26	53	15–17	1–2
30231	♂	39	regen	6.5	13.7	20	7	12	28	50	13–13	1–1
30211	♀	38.5	58	5.2	12.5	20.5	7	11	24	55	16–16	1–1
30220	♀	38	62	5.5	12	22.3	7	10	26	50	..	1–2

labials; third pair separated by a scale and each separated by a single scale from labials; five elongate infralabials.

Scales smooth, in 28 rows around middle of the body; median caudals not enlarged; 48 scales from parietals to above anus; 40 scales from axilla to groin; 16 lamellae under fourth toe with an indistinct keel or tubercle on each; adpressed hind limb separated from adpressed arm by four or five scales.

Color. Above, light wood-brown, the head not or very slightly darker than back. The dorsolateral line (present in females) is barely indicated on sides of body and neck; on tail represented by black dots on two scale rows; temporal region with some flecks and several small ocellated cream spots on temporals and posterior labials; a bright red area on chin and neck

Measurements in mm. Snout to vent, 41; tail, 41 (tip missing); arm, 8.2; leg, 12.3; axilla to groin, 22.2; snout to arm insertion, 15.3; head width, 6.1; head length, 8.

Remarks. It is entirely probable that this species is identical with the form figured by Günther in his Reptiles of British India, 1864, pl. 13, fig. B, as *Eumeces taprobanensis.* The specimen shows two primary temporals, a rather common condition in *rufogulus* and it is presumed that the frontoparietals are fused. At any rate the figure might serve very well as an illustration of this species, especially for the females. Boulenger (Catalogue, vol. 3, pp. 319-320) however has referred the figure to the true *taprobanense* and some of the other specimens mentioned by Günther to *fallax.*

A table of measurements and scale counts of a part of the paratype series is given.

GENUS CHALCIDOSEPS BOULENGER

Chalcidoseps Boulenger, Catalogue of the Lizards in the British Museum, 2d ed., vol. 3, 1887, p. 423.

Genotype. Chalcidoseps thwaitesi.

This genus has the nostril pierced in the rostral near the posterior edge. A scale lies above the first labial preceding the loreal; a very large frontonasal is present preceded by a relatively small rostral; no prefrontals or frontoparietals present. The body is elongate, with four small limbs each bearing four digits

Chalcidoseps thwaitesi (Günther)

Nessia thwaitesi Günther, Ann. Mag. Nat. Hist., ser. 4, vol. 9, 1872, p. 86 (type locality, Ceylon).

Chalcidoseps thwaitesi Boulenger, Catalogue of the Lizards of the British Museum, 2d ed., vol. 3, 1887, p. 423, pl. 38, fig. 1; and Fauna of British India, including Ceylon and Burma; Reptilia and Batrachia, 1890, p. 226, figs.; Dereniyagala, Ceylon Journ. Sci., sec. B, vol 16, (2), 1931, p. 176; Smith, Fauna of British India, etc., Reptilia and Amphibia, vol. 2, Sauria, 1935, pp. 335-336, fig. 83.

The genus has but a single species, which may be distinguished from any other known Ceylonese lizard by the generic characters listed above. It is known only from Ceylon specimens having been taken at Gammaduwa, in the Central Province. It is said to live at from 4,000 to 5,200 feet elevation among dead leaves and other vegetation.

GENUS NESSIA Gray

Nessia Gray, Ann. Mag. Nat. Hist., vol 2, 1839, p. 336.

Evesia Gray, Ann. and Mag. Nat Hist., vol. 2, 1839, p. 336. *Genotype. Evesia monodactylus* Gray (type locality unknown; presumably Ceylon.)

Pseudodactylus Fitzinger, Systema Reptilium, 1843, p. 23. *Genotype. Evesia bellii* Duméril and Bibron (= N. monodactyla).

Tetrapedos Jan, Arch. für Naturg., Berlin, 1860, p. 69. *Genotype. Tetrapedos smithii* Jan. from Ceylon.

Acontias (part) Boulenger, Catalogue of the Lizards of the British Museum, vol. 3, 1887, p. 224.

Anguiniccphalus Deraniyagala, Ceylon Journ. Sci., sec. B, vol. 18, 1934, p. 232. *Genotype. Acontias layardi* Kelaart, from Ceylon.

Genotype. Nessia burtoni Gray (type locality unknown; presumably Ceylon).

The group of species considered under this genus are undergoing a variety of evolutionary changes pointing to greater specialization. Usually loss or reduction of limbs, loss of an ear-opening, the presence or absence of toes are regarded as generic characters and such designations have been proposed. However, in the case of *Nessia*, the conformity of the scale patterns of the various species, the great similarity of the distinctive head scales seem to warrant the retention of a single genus for the series of varied forms. It is presumed that the genus has undergone its entire evolution on the Island of Ceylon since it is not known elsewhere. The closest Asiatic relative seems to be *Chalcidoseps*.

The genus *Brachymeles* comprises a group of species comparable to these forms, confined so far as is known to the Philippine Islands. There the genus is represented by some ten known species. They are widely distributed in this archipelago, being absent so far as is known however, in the Calamianes Islands and Palawan. The more generalized, more primitive forms, having typical, well-de-

veloped pentadactyl limbs are still extant. *Brachymeles schadenbergi* typifies this condition.*

One might account in part for the diversity of forms of *Brachymeles* by the archipelagic condition, obtaining at various times in geological history of the Philippines, that has allowed the factor of isolation effective play. No similar archipelagic condition exists now and it is doubtful if it has ever existed so as to play an effective part in the evolution of *Nessia* in Ceylon. One must suppose that the isolated elevated areas have provided "isolation" necessary for their diversification.

KEY TO THE SPECIES OF NESSIA

1. Two or four limbs present; interparietal broader than frontal (except *sarasinorum*); ear opening present 2
   Limbs absent 6
2. Limbs bearing clawed digits 3
   Limbs budlike, lacking clawed digits 4
3. Four limbs present, tridactyl; 24 scales at midbody ..... *burtonii*
   Four limbs present, didactyl; 24 scales at midbody ..... *didactyla*
4. Four limbs present; 24-26 scales about midbody ..... *monodactyla*
   Two limbs present; scales variable 5
5. Scale rows about midbody, 28 ..... *bipes*
   Scale rows about midbody, 22; interparietal narrower than frontal ..... *sarasinorum*
6. Snout flattened below, projecting sharklike; frontonasal one third width of rostral; ear-opening present ..... *hickanala*
   Snout not especially flat; not sharklike; frontonasal more than half length of rostral 7
7. One large elongate loreal; preoculars small; frontonasal nearly as long as rostral, ... *layardi*
   Two loreals, the posterior lower than anterior; frontonasal a little more than half of rostral length ..... *deraniyagalai*

Nessia burtonii Gray

Nessia burtonii Gray, Ann. and Mag. Nat. Hist., vol. 2, 1839, p. 336; Kelaart, Prodromus Faunae Zeylanicae, vol. 2, pt. 1, 1853, pp. 11-12; Günther, Reptiles of British India. 1864, p. 97.

Acontias burtonii Boulenger, Catalogue of the Lizards of the British Museum, vol. 3, 1887, p. 425; and Fauna British India including Ceylon and Burma, Reptilia and Amphibia, 1890, p. 227; Smith, Fauna of British India . . ., Reptilia and Amphibia, vol. 2, Sauria, 1935, pp. 357-358.

Acontias (Nessia) burtoni Deraniyagala, Ceylon Journ. Sci., sec. B, vol. 16, (pt. 2), 1931, p. 177; and *idem*, vol. 18, pt. 2, May 22, 1934, pp. 231-232.

Description. Snout subacuminate, at least twice as long as the orbit, strongly projecting beyond the lower jaw; rostral about two fifths as long as the snout; fronto-nasal longer than the rostral, distinctly narrower in front than behind; frontal longer than the fronto-nasal, mesially notched on each side by the first supraocular; interparietal broader than the frontal; parietals narrow, obliquely placed, in contact behind the interparietal bordered on each side by

* Taylor, in Lizards of the Philippines. 1922, p. 22, speaks of *Brachymeles schadenbergi* as the *most* specialized. This is *lapsus; "least specialized"* is intended.

an elongated temporal shield; 4 supraoculars, the first two in contact with the frontal; 5 superciliaries, the first much the largest; one long loreal sometimes divided in the middle; a preocular; lower eyelid an opaque disk or partly divided into scales; upper eyelid vestigial; 4 supralabials, the first very long, the second below the eye; mental large with an azygous shield behind it; ear-opening punctiform. Body very elongate; scales smooth, 26 to 28 round the forepart of the body, 24 round the middle, dorsals largest; preanals not or but feebly enlarged; limbs very short, tridactyle, clawed; forelimb originating at about the level of the 20th ventral scale, about as long as four scales, shorter than the hind limb.

Light brown above, the scales tipped or edged with dark brown, the general appearance being almost uniform brown or reddish-brown; paler below.

From snout to vent 75 mm.; tail bluntly pointed, about three quarters the length of the head and body.

Range. Central, Western and Sabaragamuwa Provinces." (from Smith, *loc cit.*)

The species is reported by Kelaart from Ambegammoa and Kaduganava (several smaller specimens).

Nessia didactyla (Deraniyagala)

Acontias (Nessia) didactylus Deraniyagala, Ceylon Journ. Sci., sec. B, vol. 18, 1934, pp. 232-233 (type locality, Polgehavala).

Nessia didactyla Smith, Fauna of British India including Ceylon and Burma, Reptilia and Amphibia, vol. 2, Sauria, Feb. 7, 1935, p. 358.

Description. "Anguiniform, with didactyle, clawed limbs. Snout bluntly acuminate, jaws overshot exposing anterior teeth of upper jaw. Lower eyelid scaly, ear small, about 7 scales behind eye which is midway between nostril and ear. Rostral covers about a third of the snout, with the nostril pierced in its anterior region and connected to the posterior margin of rostral by a groove. Frontonasal longer than the rostral, slightly shorter than the frontal which is shorter than the interparietal. The last is contiguous with the second and third supraoculars. Parietals comparatively wide, wider than the supraoculars and contiguous; behind them a row of 4 enlarged nuchals in a single transverse series.

"Supraoculars 4, the first and second form emarginations in the frontal. Supralabials 4, the first equals loreal and is 1.5 times length of rostral, the second is subocular. Mental moderate, contiguous with a single triangular chinshield behind which are three pairs of elongate shields which are separated from each other mesially by a single row of scales. Infralabials three. Body scales di-

rected ventrally, 26 round mid body and about a hundred from axilla to groin, 7 longitudinal pectoral rows. Anterior limb 23 scales behind gape, as long as rostral with two well developed clawed digits and seven scales along its edge exclusive of the digits, posterior limb longer, with 10-13 rows of scales along its edge exclusive of the digits. Preanals feebly enlarged. Caudals subequal. Extremity of the cylindrical tail is feebly compressed dorsally.

"*Colours.* Brown, the dorsal scales outlined in darker, ventrally lighter.

"*Dimensions.* Snout to ear 6.5 mm., gape 5 mm., ear to forelimb 7 mm., snout to cloaca 65 mm., tail 36 mm." (Type description.)

Range. Known only from the type locality, Polgehavala, Ceylon, elev. 241 ft.

Nessia monodactyla (Gray)

Evesia monodactylus Gray, Ann. and Mag. Nat. Hist., vol. 2, 1839, p. 336 (type locality unknown).

Nessia monodactyla Günther, Reptiles of British India, 1864, p. 97.

Acontias monodactylus Boulenger, Catalogue of the Lizards in the British Museum, vol. 3, 1887, p. 425; Fauna of British India including Ceylon and Burma, Reptilia and Amphibia, 1890, p. 228.

Evesia bellii Duméril and Bibron, Érpétologie Générale, vol. 5, 1839, p. 782. (Substitute name for *monodactyla;* same type.)

Tetrapedos smithii Jan, Arch. f. Naturg. Berlin, 1860, p. 69, pl. 2, figs. 4-12 (type locality, Ceylon).

Acontias (Nessia) monodactylus Deraniyagala, Ceylon Journ. Sci., sec. B, vol. 16, 1931, p. 178.

Nessia monodactyla Smith, Fauna British India including Ceylon and Burma, Reptilia and Amphibia, vol. 2, Sauria, Feb. 7, 1935, pp. 358-359.

Three specimens are in the EHT-HMS Collection, Nos. 30057, 30058, 30059. The following are scale counts and measurements:

	30056	30057	30058
Length of head to nuchals	6.3	6.1	5.8
Width of head	5.0	5.0	4.7
Width of body	5.5	5.7	4.8
Tail	..	46	29.8
Length to foreleg	15	14.2	13.2
Axilla to groin	65	66	48
Scales around neck	24–26	26	27
Scales on middle of body	26	24	24
Scales 1 cm. before anus	24	24	24
Ventral scales postmental to the anal scales	118	119	121
Subcaudals	..	85	83
Length of head and body	83	84	62
Length to ear opening	6.7	7	6.2

Conformation of the head scales agrees in general with the type description. The temporal bordering the parietal is divided save on one side in No. 30056 where it is single. In this same specimen

the parietals do not inclose the interparietal (an obvious anomaly). The pineal eye is strongly evident in No. 30057. A groove or a pit is present at the eyespot.

The anterior part of frontal is shorter in 30057 than in the other two specimens. Six preanals are present. There are about nine scales in a row on outer surface of limb. The loreal is larger than the first labial, and is divided in none. Five supraoculars; five supralabials; four infralabials are present. The area posterior to the anus is swollen, and covered with small scales.

As to the condition of the budlike limbs, those of Nos. 30056 and 30057 are shorter and broader than those in 30058. In the latter, the smallest specimen, the legs are somewhat longer, and taper more toward the tips. This last specimen is from Peradeniya, Ceylon. The other two are from Ceylon, but definite localities are lacking.

Nessia bipes Smith

Nessia (Evesia) smithi Deraniyagala, Ceylon Journ. Sci., sec. B, vol. 18, 1934, p. 232 (type locality, Gammaduva, Central Province, Ceylon).

Nessia bipes nov. nom. for *Nessia (Evesia) smithi* preoccupied, Smith, Fauna British India, including Ceylon and Burma; Reptilia and Amphibia, Vol. 2, Sauria, Feb., 1935, p. 359.

This species has not been adequately described. It is said to agree with *monodactyla* in the squamation of the head. It differs from that species in having a budlike pair of posterior limbs only and in having 28 scales around the body both anteriorly and in the middle.

From snout to vent 80 mm. Known only from the type specimen, from Gammaduva, Central Province.

Nessia layardi (Kelaart)

Fig. 6

Acontias layardi Kelaart, Prodromus Faunae Zeylanicae, vol. 2, 1853, pp. 12-13 (type locality, "soil of Cinnamon Gardens of Colombo, Ceylon); and Ann. and Mag. Nat. History, (2), 13, 1854, p. 26; Boulenger, Catalogue of the Lizards in the British Museum Natural History, 2d ed., vol. 3, 1887, p. 426, and Fauna British India including Ceylon and Burma; Reptilia and Amphibia, 1890, p. 228, fig. p. 227; Günther, Reptiles of British India, 1864, p. 96.

Acontias (Nessia) layardi Deraniyagala, Ceylon Journ. Sci., sec. B, vol. 16, 1931, p. 179, pl. XXXVIII.

Acontias (Anguimcephalus) layardi Deraniyagala, Ceylon Journ. Sci., sec. B, vol. 18, 1934, p. 231.

Nessia layardi Smith, Fauna of British India, including Ceylon and Burma . . ., Reptilia and Amphibia, vol. 2, Sauria, Feb. 7, 1935, p. 359, fig. 4, p. 356.

Differs from *burtonii* in the following particulars: Frontonasal broader and shorter than the frontal; three supraoculars, the first only in contact with the frontal notching its lateral margin; first superciliary larger, entering supraorbital region; a pair of nuchals often present; no ear-opening; 24-26 scales around the fore part of

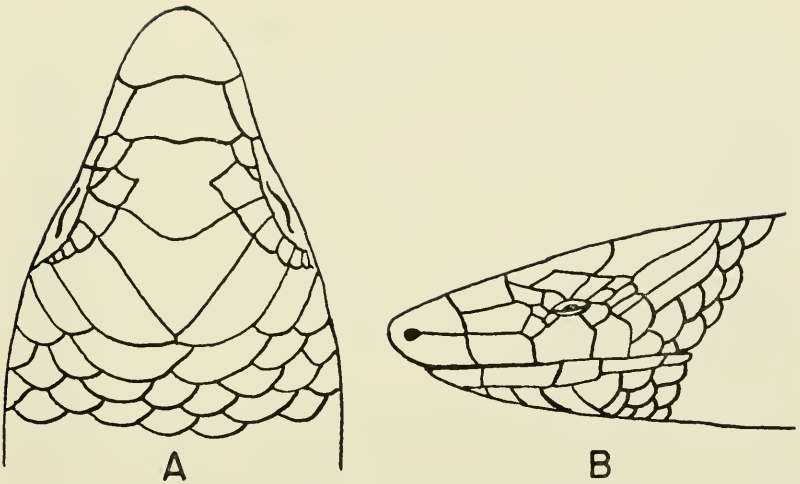

FIG. 6. *Nessia layardi* (Kelaart). Figure from Boulenger, Fauna of British India . . ., 1890, fig. 63, redrawn. Much enlarged.

the body, 22 or 24 round the middle; no limbs. On each side of the vent, in a depression of the body and more or less hidden by scales, a minute horny tubercle can be discovered with a good glass; it represents what is left of the hind limb.

A single specimen of *Nessia layardi*, U.K.M.N.H. No. 24135, was collected at Dambulla in the northern part of Central Province by Dr. W. C. Osman Hill.

The specimen, when compared to Boulenger's figure (Fauna of British India . . ., 1890, pp. 356-358, fig. 84) shows no differences of significance. However the interparietal is slightly less angular (more curved) than the figure and the first lower labial is shorter.

There are 120 scale rows (transverse) and 24 (anteriorly) to 22 (middle and posteriorly) scale rows. The total length of the eye is less than half the length of the loreal. The small nuchals are present; no ear opening. Three supraoculars are present.

There is a slight depression on each side of the body near the vent, covered with small irregular scales marking the point where the limb formerly stood.

The range of the form is Central Province and Western Province although the type locality in the latter province has been questioned by Deraniyagala (*loc. cit*).

Nessia sarasinorum (F. Müller)

Fig. 7

Acontias sarasinorum F. Müller, Verh. Nat. Gesel. Basel, vol. 8, 1889, p. 702, pl. X (type locality, Inamalua, Ceylon); Boulenger, Fauna British India, including Ceylon and Burma; Reptilia and Amphibia, London, 1890, p. 228.

Acontias (Nessia) Sarasinorum Deraniyagala, Ceylon Journ. Sci., sec. B, vol. 16, part 2, 1931, p. 178.

Nessia sarasinorum Smith, Fauna British India, including Ceylon and Burma; Reptilia and Amphibia, vol. 2, Sauria, Feb. 7, 1935, p. 360.

A specimen of this rare species, EHT-HMS No. 30003, was taken from under a log, near a small forest stream 21 mi. west of Trincomalee, Ceylon. Its movements were rather slow as it crawled in a burrow in the sandy earth.

The color was dull lavender to grayish lavender in life. Preserved it is lead color, the head, between rostral and nuchals being dark lead. The tail is regenerated, with a ventral light spot, and a dim, incomplete lighter ring on scales preceding the beginning of the regenerated part. The dorsal scales when closely examined show darker areas. There is no external trace of the front limbs, but the scale irregularities show the point where limbs were present in ancestral forms. The hind limbs are budlike, covered by four rows of scales.

There are twelve scale rows about tail, 1 cm. behind anus; 24 rows about neck; 22 about the middle of the body; 127 scales in a row from postmental to anal; 124 scales on back from parietals to level of hind limbs.

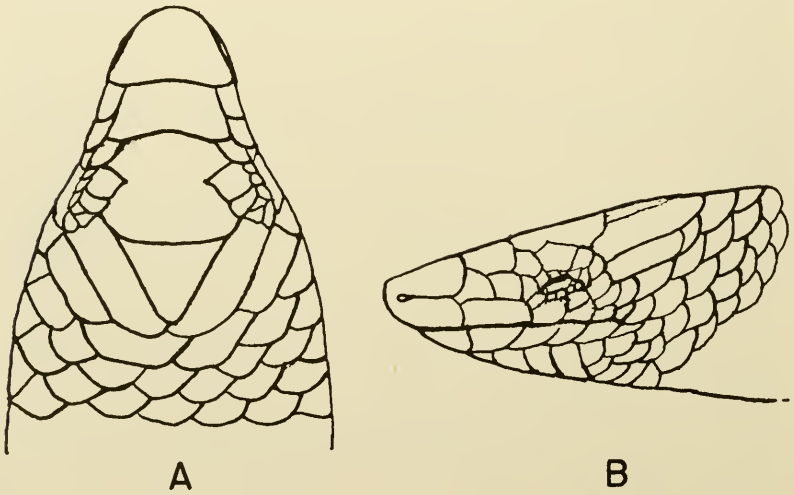

FIG. 7. *Nessia sarasinorum* (Müller). EHT-HMS No. 30003, 21 mi. w Trincomalee, Ceylon. A. Head, dorsal view. B. Head, lateral view. About × 10.

The details of the head squamation follow: Snout extending beyond mouth, covered by a thickened shield much broader than long; nostril pierced in the anterior lateral part with a suture extending back to anterior loreal; frontonasal much broader than long, broader but shorter than the frontal; latter broadly hourglass-shaped; interparietal small, triangular, narrower and shorter than frontal; parietals widened anteriorly, enclosing the interparietal; each interparietal bordered by two elongate scales, the medial of which may be regarded as nuchals; two large loreal scales of equal height; four supraoculars; a large postocular, one preocular; four superciliaries, very irregular in size; four or three suboculars (the first may be excluded from orbit). Scales of eyelids more or less fused together; four supralabials, the first equal in size to the combined loreals; four infralabials; mental thickened, followed by an azygous postmental, wider than the mental; three well-defined pairs of chinshields, the two anterior separated by a single scale; ear opening present, minute.

Snout to vent, 86 mm.; tail (regenerated), 37 mm.; diameter of head, 5 mm.; diameter of body, 5.5 mm.; snout to ear, 7 mm.

Smith (*loc. cit.*) calls attention to errors in Müller's description.

Nessia hickanala Deraniyagala

Nessia hickanala Deraniyagala, Proc. Linnean Soc. of London, 1939-40, pt. 1, Feb. 9, 1940, pp. 37-39, figs. a-d.

Description. Habit anguiniform, apodal, with a few small scales indicating the position of the hind limbs. Snout very shark-like, being convex dorsally, but strongly flattened ventrally with a prominent labial ridge; jaws overshot, but front teeth not exposed. Eye small, its lower lid covered by three transparent scales; ear small, about six or seven scales behind eye which is slightly closer to nostril than to ear. Rostral covers about three fifths of the snout, with the nostril pierced in its anterior region and connected to the posterior margin of this shield by a groove.

Frontonasal only about a third of the length of the rostral, and about half the length of the frontal, which is shorter and narrower than the interparietal. Parietals as wide as supraoculars and contiguous behind the interparietal; behind them a single transverse row of four enlarged occipitals. Supraoculars three, one large postocular. Preocular strongly enlarged, cuneiform. Supralabials four, the second is below orbit; mental moderate, contiguous with a single triangular chinshield, and with four enlarged shields along each mandible below the four infralabials, of which the last is conspicuously elongated. Body-scales directed ventrally; dorsals fee-

bly enlarged, 20-21 scales round midbody. Preanals conspicuously enlarged; caudals subequal.

Color. Pinkish-brown, darker dorsally, each scale-pocket a dark brown which becomes reduced with age. After death the pink is replaced by a pale grey.

Measurements (of largest specimen). Snout to vent, 92 mm.; around body in middle, 17 mm. (Of type: Snout to vent, 68 mm.; snout to ear, 7 mm.) The tails of all known specimens were either mutilated or regenerated.

The above description is taken almost wholly from the type description.

Nessia deraniyagalai, sp. nov.

Fig. 8

Type. EHT-HMS No. 30059 ♂, collected 16 mi. N Trincomalee near shore, on small hillock at an elevation of about ten meters, Oct. 24, 1944, E. H. Taylor, collector.

Diagnosis. A legless *Nessia,* differing from the legless *N. layardi* in having two, instead of one loreal, the anterior much the higher; a frontoparietal much broader than frontal but only five eighths as long; part of frontal anterior to lateral notch of much larger area than part posterior to notch; frontoparietal wider than frontal; second supralabial not higher than the much enlarged first. Scale

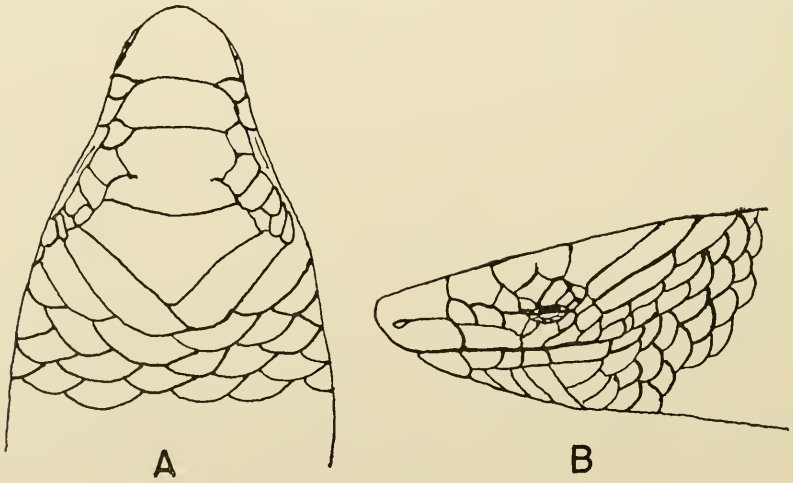

FIG. 8. *Nessia deraniyagalai* sp. nov. EHT-HMS No. 30059. 16 mi. N Trincomalee, Ceylon. Type. A. Head, dorsal view. B. Head, lateral view. × 10.

rows about body: anteriorly, 22, not extending to midbody, where there are 20; 18, one cm. in front of tail.

Description of species. Snout covered with a much thickened rostral plate, more than one and one half times as wide as long; nostril pierced laterally, with a long suture from it passing back to the first loreal; posterior lateral border of rostral somewhat emarginate; frontonasal as wide as rostral, but somewhat shorter; wider than frontal, but latter one and one half times as long; frontal narrowed medially with short lateral sutures, the anterior part of greater width and area than posterior part; frontoparietal wider than frontal, angular posteriorly, convex anteriorly; parietals narrowed somewhat anteriorly, in contact posteriorly, bordered behind by a pair of nuchals and an elongate temporal; two loreals, anterior higher; five supraoculars (the anterior of which may actually represent a greatly enlarged superciliary), (?) three or four superciliaries; five supralabials, first large, elongate, second borders orbit, separated from eye by two minute scale rows on lower eyelid; a preocular; a small presubocular and a postsubocular, the latter above third labial; four infralabials, the posterior elongated; mental thickened, extending back almost as far as the rostral seen from below, and distinctly longer than portion of rostral extending beyond the mouth; postmental narrower and shorter, the posterior edge rounded somewhat; three pairs of chinshields, the second widest, the two anterior separated by a single median scale. Lower eyelid movable, the eye slit two thirds millimeter in length; no ear opening (however in the normal ear position there is a slight lateral depression with one or two minute scales); limbs absent but usual position marked by an irregularity in a single scale on each side; 22 scales on neck; 22 on anterior part of body; 20 at exact midbody; reduced to 18 a centimeter anterior to anus; no hind limbs, the position marked by some irregularities in the scales but no tubercle or remnant of the limb can be discerned; 121 scale rows on dorsum from nuchal to above anus; 125 from postmental to anal shield; 95 ventral scales from anus to tip of tail (complete).

Color. Ground color brownish fawn, each scale with a semilunar spot of dark brown on its extreme anterior part and thus covered by the preceding scale, the spots not or but rarely contiguous; spots forming longitudinal rows as well as diagonal rows. An indefinite blackish brown area above eye, continued down across the preocular.

Measurements. Total length, 130 mm.; snout to vent, 80 mm.; tail, 50 mm.; width of head (greatest), 4.15 mm.; length of head to posterior edge of parietals, 5.6 mm.; width of body, 5 mm.

Remarks. At least two species occur in the flat northern lowlands. These are *Nessia sarasinorum* and the present species. The character of the head scales (especially in regard to the loreals) differs in numerous regards from *Nessia layardi* with which it agrees in absence of limbs and ear-opening.

The species is named for Mr. P. E. P. Deraniyagala, noted Ceylonese herpetologist, and Director of Museums, Ceylon.

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The Snakes of Ceylon

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ABSTRACT: The report is based primarily on the Ceylonese snakes in the collection of the United States National Museum, and those in the Edward H. Taylor-Hobart M. Smith collection at Lawrence, Kansas. The paper also includes a few specimens recently received in exchange from Dr. W. C. Osman-Hill and now in the University of Kansas Collection.

Two new species, *Ahaetulla oliveri,* and *Lycodon osmanhilli* are described. Scale data are included for most of the specimens in the collections.

The island of Ceylon is situated southeast of the tip of the Indian peninsula at a distance of about 40 miles from the mainland. The distance between is partially bridged by a small peninsula and several islands, commonly called Adam's Bridge. The peninsula pushes off from the mainland not far from the mouth of the Vaigai river and is, seemingly, a part of the delta of that river. Separated from the peninsula by the narrow Pamban Pass is Rameswaram island, several miles long. From the Ceylon side six islands stretch out towards India separated from each other by narrow straits usually less than two miles wide and from Rameswaram Island by a gap of approximately 20 miles of very shallow water, so shallow in fact that from the air the bottom can be seen for much, if not all the distance.

W. T. Blanford* states that in Eocene and Miocene time the western coast of India lay farther westward than it does at present but that this western extension has disappeared through subsidence leaving several island groups. R. D. Oldham* has postulated that the subsidence was accompanied by the formation of a

* H. B. Medlicott and W. T. Blanford. A Manual of the Geology of India, 1st ed., 1879; 2d ed., 1893 (by R. D. Oldham).

great fault along the west coast. Depths of 2,000 fathoms are now known between the mainland of India and these islands, the Maldive, Laccadive and Chagos archipelagoes, which were presumably a part of the mainland formerly.

There is evidence † of a more recent (possibly Pleistocene) subsidence. Excavations for a dock in Bombay have revealed a submerged forest, some of the stumps being thirty feet below sea level.

Moreover the reptilian fauna of Ceylon is similar enough to southern India to warrant a postulation that the separation of Ceylon from the continent has taken place in relatively recent times, and that the bulk of the fauna reached Ceylon at a time when the connection was present, and at a much later time than Eocene or Miocene.

That Ceylon has been affected by subsidence in this general area would seem quite likely. A very small elevation of the land now would again bring Ceylon in contact with India; or even a lowering of the sea surface by the piling up of glacial ice on the land might affect sea levels to such an extent as to bring about its union with the mainland. If subsidence has been a slow process corals might keep the isthmus built up to near sea level much as occurs in the formation of atolls. I do not know whether Adams bridge shows such a condition or not.

The serpent fauna of Ceylon bears a close relationship to that of the neighboring part of India. This is true for practically all genera known in Ceylon; but the fauna is far from being identical. Many species have been reported as occurring in both India and Ceylon and are or have been regarded as being identical subspecifically. However, some of the more recent work of Wall (1921), Smith (1943) and Deraniyagala (1948) recognizes subspecific differences in certain forms previously regarded as identical by Boulenger (1890).

The fact remains that the matter of subspecific and specific differences in the faunas of the two areas is still not clearly defined. Colonel Wall, who has written on Ceylon faunae, but whose primary field of interest was the Indian serpent fauna, all too often in his Ophidia Taprobanica utilized Indian specimens for his descriptions, and as a basis for data given on the species. In consequence it is often impossible to judge from his work the exact status of a Ceylon form, and the extent to which it differs from that of the Indian mainland. I venture to suggest that one of the most important

† R. B. S. Sewell, Mem. Asia Soc. Bengal, 1935.

contributions one might make to the herpetology of Ceylon would be accumulation of considerable series of specimens from many parts of the Island, as well as from the adjoining southern part of India. Then, and only then, will it be possible to determine the true relationships and the taxonomic status of many of the forms here treated. I anticipate that a study of such material would reveal many other forms differing from Indian species; and furthermore one would expect to find certain Indian species represented by two or more subspecies in Ceylon.

There is some evidence of relationship indicated between faunas of Madagascar and Ceylon. This has been usually explained either by postulating the presence of a continental land mass connecting Ceylon, South India and Madagascar most of which is now lost by subsidence; or by postulating "floating continents." The evidence based on the serpent fauna is indeed small. However the presence of a species of *Sibynophis* in Ceylon and two in Madagascar (one also in the Comoro Islands), and their presumed absence in Africa needs some special explanation. This is made even more evident if one considers the close relationship between the Ceylon lizard genus, *Nessia,* and the Madagascar *Acontias.* Similar relationships between Ceylon and Madagascar are evident in certain other vertebrate groups.

A careful examination of the serpent fauna indicates differences that suggest early arrivals in the country and late arrivals, although the actual or approximate geologic time might be impossible to determine. This is based primarily on degree or extent of evolution. One might regard Typhlopidae and Uropeltidae, each with several endemic species, as belonging in a class with the early arrivals. Each of these must have undergone a long evolution on the island, despite the fact that certain widespread forms of the families occur both in India and Ceylon. Of the very large group comprising the Colubridae I would regard the Sibynophinae, with the genus *Sibynophis,* and *Aspidura* of the Colubrinae, as two of the older genera in Ceylon.

There are five genera presumably endemic in Ceylon: *Pseudotyphlops* belonging to the Uropeltidae with one species; *Cercaspis* with a single species, having highly modified vertebrae; *Haplocercus* with one species; *Balenophis,* an opisthoglyph with specialized nuchal glands; and *Aspidura* with five species (one of which has been reported from the Maldive Archipelago to the west of Ceylon).

The last four mentioned forms are members of the subfamily Colubrinae.

From the evidence at hand the presumably ancient snakes comprising the Anillidae and Boidae have had their evolution elsewhere and only the end products of their evolution persist. These may very probably have reached Ceylon at relatively late periods after the maximum of their specific plasticity had passed. At least the present evidence points to little evolution of these snakes in the islands. However Deraniyagala considers *Python molurus* worthy of subspecific recognition and names the Ceylon form, *P. m. pimbura,* chiefly on the character of the body pattern (a figure is included here showing both dorsal and lateral markings as well as the dorsal squamation of the head) (Pl. XIII, fig. 1).

Among the other families the Viperidae is represented by three forms, two of which are regarded as identical to the Indian forms (*Vipera russelli* and *Echis carinatus*). These possibly are of recent arrival since *E. carinatus* is found only in the extreme northern part and *V. russelli* apparently is in lowland chiefly; this despite the fact that in India it has been reported up to elevations of 7,000 ft. On the other hand the pit vipers (*Trimeresurus* and *Agkistrodon*) seem to have undergone considerable evolution in the islands and may have preceded the two genera mentioned previously by considerable time. One typical *Trimeresurus* is endemic at high elevation in Ceylon, and the genus *Agkistrodon* has itself undergone change and one endemic form is recognized.

Representing the Elapidae are three genera: *Bungarus* with two species (one endemic); *Naja* with presumably one subspecific representative; and *Callophis* with a form probably subspecifically distinct from Indian forms (here not so regarded).

The table which follows compares the fauna of southern India and Ceylon by genera: The endemic genera in southern India are six, while endemic genera in Ceylon number five (in one of these, a species is represented also in the Maldive Archipelago but not in India). There are 74 species in Ceylon, of which 37 are presumably endemic. In southern India 102 species are known.

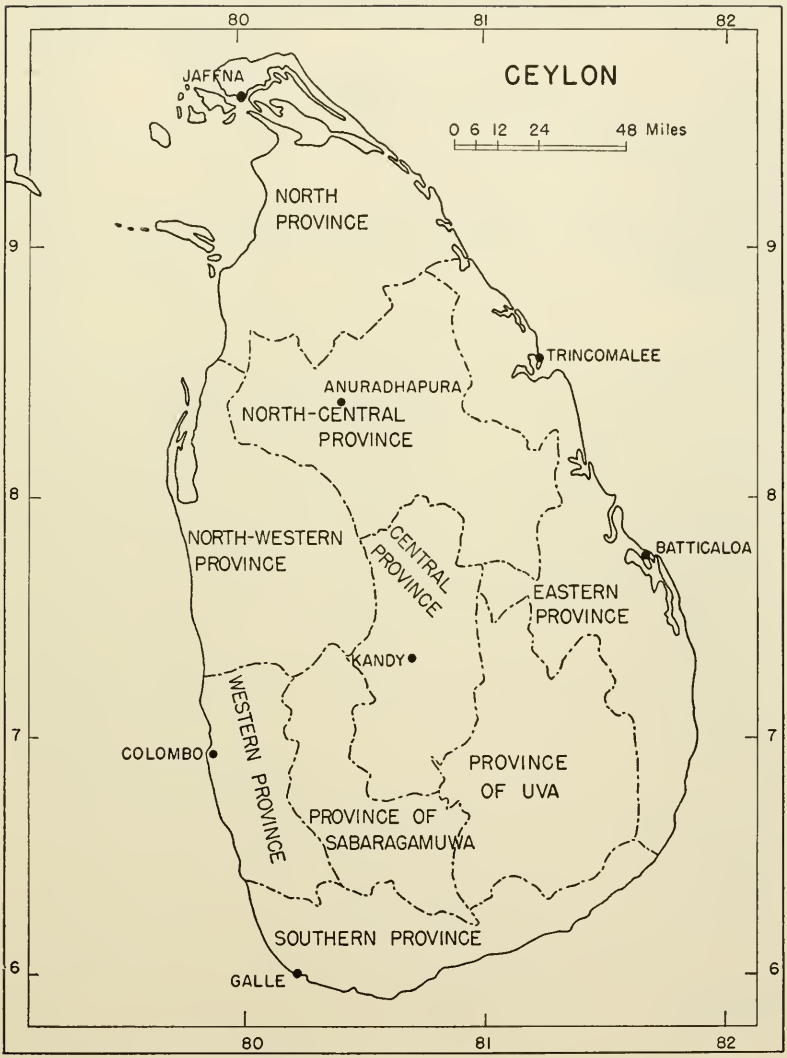


FIG. 1. Map of Ceylon showing provinces.

TABLE OF SNAKE GENERA FOR PENINSULAR INDIA AND CEYLON EXCLUSIVE OF THE SEA SNAKES HYDROPHIIDAE

	Ceylon	Ceylon endemic species	India
Typhlops	10	8	6
Uropeltis	2	2	14
Melanophidium	..	..	3
Platyplectrurus	..	..	2
Teretrurus	..	..	2
Plectrurus	..	..	4
Rhinophis	7	7	3
Pseudotyphlops	1	1	..
Cylindrophis	1	1	..
Python	1	..	2
Eryx	1	..	2
Acrochordus	1	..	1
Sibynophis	1	..	1
Elaphe	1	..	1
Ptyas	1	..	1
Coluber	1	..	1
Liopeltis	1	..	2
Oligodon	4	1	9
Ahaetulla	4	1	5
Chrysopelea	2	1	2
Lycodon	3	1	4
Cercaspis	1	1	..
Dryocalamus	2	..	2
Natrix	3	1	4
Balanophis	1	1	..
Macropisthodon	1	..	1
Atretium	1	..	1
Rhabdops	..	..	1
Aspidura	5	4	(1 Maldive A.)
Haplocercus	1	1	..
Xylophus	..	..	2
Boiga	5	2	3
Dryophis	2	2	4
Enhydrus	..	..	1
Hurria	1	..	1
Gerardia	1	..	1
Bungarus	2	1	2
Callophis	1	..	3
Naja	1	..	2
Vipera	1	..	2
Echis	1	..	1
Agkistrodon	2	1	2
Trimeresrus	1	1	4

FAMILY TYPHLOPIDAE

A single genus, *Typhlops*, is represented in Ceylon, no less than ten species being present.

GENUS TYPHLOPS Oppel

Typhlops Oppel, Die Ordnungen, Familien und Gattungen der Reptilien . . ., 1811, p. 54.

Genotype, *Anguis lumbricalis*.

The snakes of the genus *Typhlops* that are known to occur in Ceylon have been treated in a special paper.* However, in order that the listing here may be complete, I have also included these species.

KEY TO THE SPECIES OF TYPHLOPS IN CEYLON

1. Scales in 18 longitudinal rows about body; nasal variable 2
   Scales in 20 or 22 rows about body; nasal divided 4
2. Nasal incompletely divided, the suture to 2d labial; no subocular; small terminal tail spine; eye distinct; 330-360 transverse scale rows; length 285 mm.; blackish brown above, paler below ..... *T. porrectus*
   Nasal completely divided, the suture to 2d labial; a subocular present; no terminal tail spine; eye usually not visible 3
3. Upper (posterior) nasals separated behind rostral; 330-360 transverse scale rows on body, brown above, paler below; length 140 mm.; head partly or almost entirely cream ..... *T. mirus*
   Upper (posterior) nasals forming a median suture behind the rostral; 330 transverse scale rows on body; brown above, yellowish white below; length 140 mm. ..... *T. ceylonicus*
4. Scales in 20 longitudinal rows about body 5
   Scales in 22 longitudinal rows about body; eye distinct; nasal suture to 2d labial; (260-280 scale rows, said to agree with *jerdoni*). Black above, whitish below, the colors meeting in a clear line of demarcation; length 130 mm., *T. leucomelas*
5. Nasal suture goes to the preocular 6
   Nasal suture goes to second labial 9
6. Transverse rows of scales on body more than 280 8
   Transverse scale rows on body less than 275 7
7. Transverse scale rows, 229-261 on body; subsquamous glands on head forming distinct pattern; eye distinct; underside of head largely cream; part of rostral visible above shorter; length 130 mm. ..... *T. lankaensis*
   Transverse scale rows on body, 245; subsquamous glands on head not visible; eye rather indistinct; part of rostral visible above much elongate; snout somewhat truncate at tip; dull violet to lavender; length 111 mm. ..... *T. violaceus*
8. Transverse scale rows on body, 290-330. Pattern of subquamous glands distinct; eye normally distinct; blackish brown above, paler below; length 170 mm., *T. braminus*
9. Body more attenuated; transverse scale rows on body above 290 10
   Body less attenuated; transverse scale rows 261-273; body brownish above, the pigment becoming less on sides; venter cream save for a pigmented band on throat; eye distinct; width into body length, about 31 times; length 107 mm., *T. malcolmi*
10. Transverse scale rows, 298-326; width of the body into length about 43 to 56 times; light brown above, lighter below. Scales bordering mouth cream; snout rounded anteriorly; upper nasal one-third larger than lower; 3d labial about half area of fourth; length 112 mm. ..... *T. tenebrarum*
    Transverse scale rows 295; body width into total length about 60 times; head truncate, subsquamous glands not or scarcely discernible; length 90 mm., *T. veddae*

* Taylor, E. H. Comments on Ceylonese Snakes of the Genus *Typhlops* with descriptions of new species. Univ. Kansas Sci. Bull., vol. 31, pt. 2, 1947, pp. 283, 298, figs. 1-3.

Typhlops porrectus Stoliczka

Typhlops porrectus Stoliczka, Journ. Asiat. Soc. Bengal, vol. 40, 1871, p. 426, pl. 25, figs. 1-4 (type locality, Bengal, India); Méhely, Termes. Füzetek, vol. 20, 1897, p. 62 (Kala-wewa, Ceylon); Smith, Fauna British India, Ceylon and Burma including the whole Indo-Chinese Subregion; Reptilia and Amphibia, vol. 3, 1943, p. 46 (Punduloya, Ceylon); Taylor, Univ. Kansas Sci. Bull., vol. 31, pt. 2, 1947, p. 284.

This species is widespread in India but apparently it is uncommon in Ceylon. Two records, that of Méhely in 1897, and that of Smith in 1943 are the only specimens that have been reported.

Typhlops mirus Jan

Typhlops mirus Jan, Iconographie Générale des Ofidiens, livr. 1, 1860, p. 9, pls. 5 and 6, fig. 7 (type locality, Ceylon); Günther, Reptiles of British India, 1864, p. 176, pl. 16, fig. H; Theobald, Descriptive Catalogue of the Reptiles of British India, 1876, p. 126; Boulenger, The Fauna of British India including Ceylon and Burma; Reptilia and Batrachia, 1890, p. 240; and Catalogue of the Snakes in the British Museum (Natural History), vol. 1, 1893, p. 52, Wall, Ophidia Taprobanica or the Snakes of Ceylon, 1921, pp. 7-9, fig. 1; Journ. Bombay Nat. Hist. Soc., 29, 1923, p. 348; Smith, The Fauna of British India including Ceylon and Burma; Reptilia and Amphibia, vol. 3, Serpentes, Dec., 1943, p. 55 (Ceylon. Known definitely from Peradeniya); Taylor, Univ. Kansas Sci. Bull., vol. 31, pt. 2, 1947, pp. 284-285.

Two specimens, EHT-HMS No. 30094, from Peradeniya, Ceylon, and U. S. N. M. No. 56287 "Ceylon" are in the collection. The transverse scale rows of these specimens are 317 and 298, respectively.

Typhlops celyonicus Smith

Typhlops mirus Wall (part), Ophidia Taprobanica or the Snakes of Ceylon, Colombo, 1923, p. 7. (In one place, in a table, the nasals are reported as meeting behind rostral. At the bottom of the page he states "sometimes in contact behind the rostral.")

Typhlops ceylonicus Smith, Fauna of British India, Ceylon and Burma, including the whole of the Indo-Chinese Subregion; Reptilia and Amphibia, vol. 3, Serpentes, Dec., 1943, pp. 55-56 (type locality, Peradeniya, Ceylon); Taylor, Univ. Kansas Sci. Bull., vol. 31, pt. 2, 1947, pp. 284-285.

The type of this species is unique.

Typhlops braminus (Daudin)

Eryx braminus Daudin, Histoire naturelle générale et particulière des Reptiles, vol. 7, year 11 (= 1803), pp. 279-280. Based on Russell's *Rondou-Taloulou-pam* in An account of Indian Serpents collected on the Coast of Coromandel, vol. 1, p. 48, pl. 43 (type locality, Vizagapatam, India).

Typhlops braminus Boulenger, Catalogue of the Snakes in the British Museum (Natural History), vol. 1, 1893, p. 16; Wall, Ophidia Taprobanica or the Snakes of Ceylon; Colombo, 1921, pp. 7, 9-13 (figures apparently represent another species); Smith, The Fauna of British India, Ceylon and Burma, including the whole of the Indo-Chinese Subregion; Reptilia and Amphibia, vol. 3, Serpentes, Dec., 1943, pp. 46-48, fig. 14, head; Taylor, Univ. Kansas Sci. Bull., vol. 31, pt. 2, 1947, pp. 290-291.

Two specimens are in the U. S. N. M. collection, Nos. 120336, 120337 from Clodagh Estate, Rattota, Matale District, and a single specimen is in the EHT-HMS collection from Peradliniya, Central Province. The ventral scales from mental to vent are, respectively, 297, 325, and 317.

Typhlops malcolmi Taylor

Typhlops malcolmi Taylor, Univ. Kansas Sci. Bull., vol. 31, pt. 2, 1947, pp. 291-292 (type locality, 12 mi. N Trincomalee, Ceylon).

The species is known from the type and a single topotypic paratype specimen, both in the EHT-HMS collection.

A small bicolored snake having 20 longitudinal scale rows; 261-273 transverse scale rows around body; fourth labial twice as large as third, notched behind; a single postocular present; brown above and cream below with a brownish pigmented band crossing throat. Glands on head form a distinct, lighter pattern.

Typhlops violaceus Taylor

Typhlops violaceus Taylor, Univ. Kansas Sci. Bull., vol. 31, pt. 2, 1947, pp. 289-290 (type locality, 12 mi. N Trincomalee, Ceylon).

This species is known from the type specimen (EHT-HMS collection) only, and may be diagnosed as follows: A small *Typhlops* with eyes dim, but discernible; the nasal completely divided, the nostril lateral but not visible above, the suture dividing nasal touching the preocular far from the labial; 20 longitudinal scale rows; none or only a very small terminal spine; 245 transverse scale rows on body; body width in total length about 31 times. Color, dull violet to lavender, almost the same above and below.

Typhlops veddae Taylor

Typhlops veddae Taylor, Univ. Kansas Sci. Bull., vol. 31, pt. 2, 1947, pp. 294-296, figs. 3, A-B (type locality, 12 mi. N. Trincomalee, Ceylon).

The unique type specimen is in the EHT-HMS collection. The diagnostic characters are as follows: A very slender *Typhlops* having 20 scale rows, no subocular, the nasal suture to the second labial, the rostral short failing to reach back to eye level by a considerable distance; head somewhat narrowed, and truncate anteriorly; the transverse scale rows about body 295; 14 caudal rows; body width in length about 60 times.

The species, judging by its very slender habitus, and the large number of transverse scale rows is related to *Typhlops braminus,* and to *Typhlops tenebrarum,* described recently. It differs from the former in color, characteristic pattern of glands, and in having the nasal suture touch the labial rather than the preocular. The shape of the head and particularly the shape of the snout, is quite different; the eye is dim, and the diameter of the body is contained in its length 60 instead of "30-45" times, and the tail is proportionally longer.

The type was taken from decaying wood debris, in second growth forest.

Typhlops leucomelas Boulenger

Typhlops leucomelas Boulenger, The Fauna of British India including Ceylon and Burma; Reptilia and Batrachia; London, 1890, pp. 237-238 (type locality, Haycock Mountain, 40 mi. from Galle, Ceylon, 2,000 ft. elevation); and Catalogue of the Snakes in the British Museum (Natural History), vol. 1, 1893, pp. 18-19, pl. 1, fig. 4; Wall, Ophidia Taprobanica or the Snakes of Ceylon, 1921, pp. 13-15, fig. 4; and Spolia Zeylanica, vol. 12, 1922, p. 253; and Journ. Bombay Nat. Hist. Soc., 29, 1923, p. 350; Smith, The Fauna of British India, Ceylon and Burma including the whole of the Indo-Chinese Subregion; Reptilia and Amphibia, vol. 3, Serpentes, Dec., 1943, p. 50; Taylor, Univ. Kansas Sci. Bull., vol. 31, pt. 2, 1947, pp. 286-287.

No specimens of this species are in the collection.

Typhlops lankaensis Taylor

Typhlops lankaensis Taylor, Univ. Kansas Sci. Bull., vol. 31, pt. 2, 1947, pp. 287-289, figs. 1, A and B (type locality, 12 mi. N Trincomalee, Ceylon).

This form occurs commonly in the Trincomalee area. The type and 24 paratypes are in the EHT-HMS collection. The diagnostic characters follow:

Head oval, seen from above; suture, dividing nasal completely, reaches to preocular; 20 scale rows about body; rostral somewhat less than one third greatest width of head; transverse scale rows about body, 229-261; generally brown to gray-brown above with very dim longitudinal dorsal lines, the median most distinct; under side of head very largely cream color.

Typhlops tenebrarum Taylor

Typhlops tenebrarum Taylor, Univ. Kansas Sci. Bull., vol. 31, pt. 2, 1947, pp. 292-294, figs. 2, A-C (type locality, 12 mi. N. Trincomalee, Ceylon).

The type and three paratypes are in the EHT-HMS collection. The diagnostic characteristics of the species are as follows: A very slender *Typhlops* with the nasal suture completely dividing the nasal and reaching the second labial; width contained in length from about 43 to 56 times; number of transverse scale rows about body from about 298 to 326 rows; 12 to 14 on tail; 20 longitudinal scale rows about body; light brown above, lighter below and on sides; scales bordering the mouth cream color.

FAMILY UROPELTIDAE

Of this family the genera *Uropeltis, Rhinophis,* and *Pseudotyphlops* occur in Ceylon. *Uropeltis* is represented by two endemic species (a third form bears the name *ceylonicus* but apparently it is an Indian snake). *Rhinophis* by eight species and *Pseudotyphlops* by one. Thus eleven of the 45 species known are Ceylonese. One

genus, *Pseudotyphlops*, and eight of the eleven known *Rhinophis* are endemic in Ceylon. However, of the species of *Uropeltis*, 20 of the 22 known species are Indian in distribution.

KEY TO THE CEYLONESE GENERA OF UROPELTIDAE

1. Tail usually obliquely truncate, the truncate portion covered with thickened differentiated scales; terminal caudal scute ending in a transverse ridge, or two points side by side ..... *Uropeltis*
   Tail not obliquely truncate 2
2. Tail ending in a convex or flattened, rounded, rugose shield ..... *Rhinophis*
   End of tail with a large, subcircular, flat, spinose shield above ..... *Pseudotyphlops*

GENUS RHINOPHIS Hempricht

Rhinophis Hempricht, Grundriss der Naturgeschichte, 1820, p. 119.
Genotype, *Tylops oxyrhynchus;* Wagler, Natürliches System der Amphibien, 1830, p. 195.

The genus is represented by eight species in Ceylon. Three others occur in India.

KEY TO THE SPECIES OF RHINOPHIS IN CEYLON

1. Rostral lacking a ridge 2
   Rostral more or less distinctly ridged 3
2. Ventrals 148-168; dark brown, each scale below with a yellow spot or margin; yellow vertical spots on each side on anterior part of body usually connected by a lateral stripe; length 370 mm. ..... *blythi*
   Ventrals 173-191; brown above, uniform or each scale with a white area or margin, more extensive below; light spots may be present, or bars on sides; a ring around base of tail; length 300 mm. ..... *drummondhayi*
3. Rostral equal or less than half the length of the headshields; rostral obtusely ridged 4
   Rostral more than half the length of the headshields; strongly ridged 5
4. Ventrals 180-204; blackish brown, the scales with lighter margins; a series of cream spots along sides ..... *homolepis*
   Ventrals 153-182; brown above and below with the scales somewhat lighter margined; no lateral cream spots ..... *philippinus*
5. Uniform brown above and below; ventrals 211-227; rostral reddish .... *oxyrhynchus*
   Not uniform brown above and below 6
6. A black vertebral line between two light lines 7
   No black vertebral line between two light lines 8
7. Ventrals 236-246; diameter in length 46 times ..... *punctatus*
   Ventrals 281; diameter in length 76 times ..... *porrectus*
8. A broad orange stripe dorsally, bearing black blotches; ventrals 238 ....*dorsimaculatus*

Rhinophis blythi (Kelaart)

Rhinophis blythi Kelaart, Prodromus Fauna Zeylanica, vol. 2, 1854, p. 14 (type locality, Mountains of Ceylon); Smith, Fauna of British India . . ., Reptilia and Amphibia, vol. 3, 1943, pp. 88-89.

No specimens in the collection.

Rhinophis drummondhayi Wall

Rhinophis drummondhayi Wall, Ophidia Taprobanica or the Snakes of Ceylon, 1921, pp. 43-44 (type locality, Uva Patnas, Ceylon).

No specimens in the collection.

Rhinophis porrectus Wall

Rhinophis porrectus Wall, Ophidia Taprobanica or the Snakes of Ceylon, 1921, pp. 35-36 (type locality, "on road between Puttalam and Chilaw").

No specimens in the collection.

Smith has placed this form in the synonymy of *Rhinophis punctatus*. I cannot agree since the characters are too striking to warrant such an association. The ventral count is 281, 35 above the highest known count for *punctatus*, and the body is slenderer, the diameter in total length about 76 times while Smith's specimen of *R. punctatus* has the diameter in total length, 47.5 times.

The length is 355 mm. The head is black brown, while the tip of snout is dull orange. A narrow blackish brown vertebral line passes from the nape to near the end of the body occupying the medial part of the vertebral scale row. This is bordered by whitish stripes. The caudal shield is dull orange with a subterminal dark mark. The species is known from Northwest Province.

Rhinophis punctatus Müller

Rhinophis punctatus Müller, Tiedemann and Treviranus Zeitschrift für Physiol., vol. 3, p. 1832, pp. 248-249, pl. XXI, figs. 1-3 (cranium), pl. 22, figs 1, a-c (head), d-f (tail) (type locality, Ceylon); Peters, De Serpentum familia Uropeltaceorum, 1861, pp. 12-13, pl. 2, fig. 3; Smith, Fauna of British India . . ., Reptilia and Amphibia, vol. 3, 1943, p. 92 (in part).

No specimen is in the collection. The characters given in the key will suffice to separate the form from others known in Ceylon. The species is reported from Central Province: Kandy and Peradeniya.

Rhinophis philippinus (Cuvier)

Typhlops philippinus Cuvier, Règne Animal, 2d ed., vol. 2 1829, p. 74.

Rhinophis philippinus Müller, Tiedemann's und Treviranus' Zeitschrift für Physiol., vol. 4, 1832, p. 249; Duméril, Bibron and Duméril, Erpétologie Générale, vol. 7, 1854, p. 154, Atlas, pl. 59, fig. 1; Peters, De Serpentum familia Uropeltaceorum, Berlin, 1861, pp. 15-16; Günther, Reptiles of British India, 1864, p. 184; Smith, Fauna of British India . . ., Reptilia and Batrachia vol. 3, 1943, p. 91.

Rhinophis planiceps Peters, De Serpentum familia Uropeltaceorum, Berlin, 1861, p. 17, pl. 1, fig. 9.

A specimen in the EHT-HMS collection (No. 30387) from Peradeniya and U. S. Nat. Mus. No. 56402, "Ceylon," are referred to this species. The first is uniform brownish, the scales showing somewhat lighter edges, the ventral scale rows having the light edges a little wider than the dorsals. The under side of the snout, the lower labials and most of the two anal plates are cream. The top of the head is convex, not flattened, and the rostral length above is somewhat more than one third of the shielded part of head, but much less than one half. There are four supralabials and three infralabials. An azygous preanal, triangular in shape is present. The

anal is large and divided, followed by a divided postanal only a little smaller than anal. This is followed by five subcaudals all of which are undivided except the fifth. The shield on the tail is as long as the shielded part of the head. The ventrals are 155 in this male specimen; subcaudals as described, five.

No. 56402 is blackish brown with light edges on the scales. The under side of the labials and rostral, and a part of the divided anal scale are cream. The ventrals are 174 ♀ ; subcaudals: one divided postanal followed by a divided subcaudal and one single scale totalling three.

Two specimens, U.K.M.N.H. Nos. 21433 "Ceylon," and 21434 Polgahaivela, Ceylon, have the following characters respectively: total length, 183 mm., 176 mm.; tail, 5, 7; ventrals, 177, 179; subcaudals, 3, 6; scale formulae, 19, 17, 17, 17; 19, 17, 17, 17; diameter of body, 8.8 mm., 6.8 mm.

The rostral length is slightly less than its distance from the rostral to back of frontal in both. In the longer the rostral separates the prefrontals for less than one half the suture, in the shorter the separation is more than half the length of the suture.

Rhinophis oxyrhynchus (Schneider)

Pl. XII, fig. 2

Typhlops oxyrhynchus Schneider, Historia Amphibiorum, vol. 2, p. 341 (type locality, Ceylon).

Rhinophis oxyrhynchus Hempricht, Grundriss der Naturgeschichte, 1820, p. 119; Duméril, Bibron and Duméril, Erpétologie Générale, vol. 7, 1854, pp. 156-157 (*oxyrhynchus*).

Dapatnaya lankadivana Kelaart, Prodromus Faunae Zeylanicae, vol. 2, 1854, pp. 16-17 (type locality, "Common at Trincomalee and in the Kandyan Province").

Myrilia unimaculata Gray, Proc. Zool. Soc. London, 1858, p. 264, fig. (type locality, Ceylon).

I collected a specimen, EHT-HMS No. 31256, about 6 miles north of Trincomalee that is typical in its general characters. The ventrals are 216; the subcaudals 8; the scale rows on neck, 19; on the body 17. A pair of elongate postanal scales are followed by seven subcaudals. The median dorsals are much widened on tail. The rostral is distinctly longer than its distance to the back of the parietals. The length is 329 mm., the tail, 8 mm. The diameter of the body is 8 mm.

The species is known from Northern and Eastern provinces (in the north). I collected a specimen crawling in the road at midday 14 miles north of Trincomalee. It escaped from a faulty collecting bag into a raft while crossing a lagoon and could not be recovered.

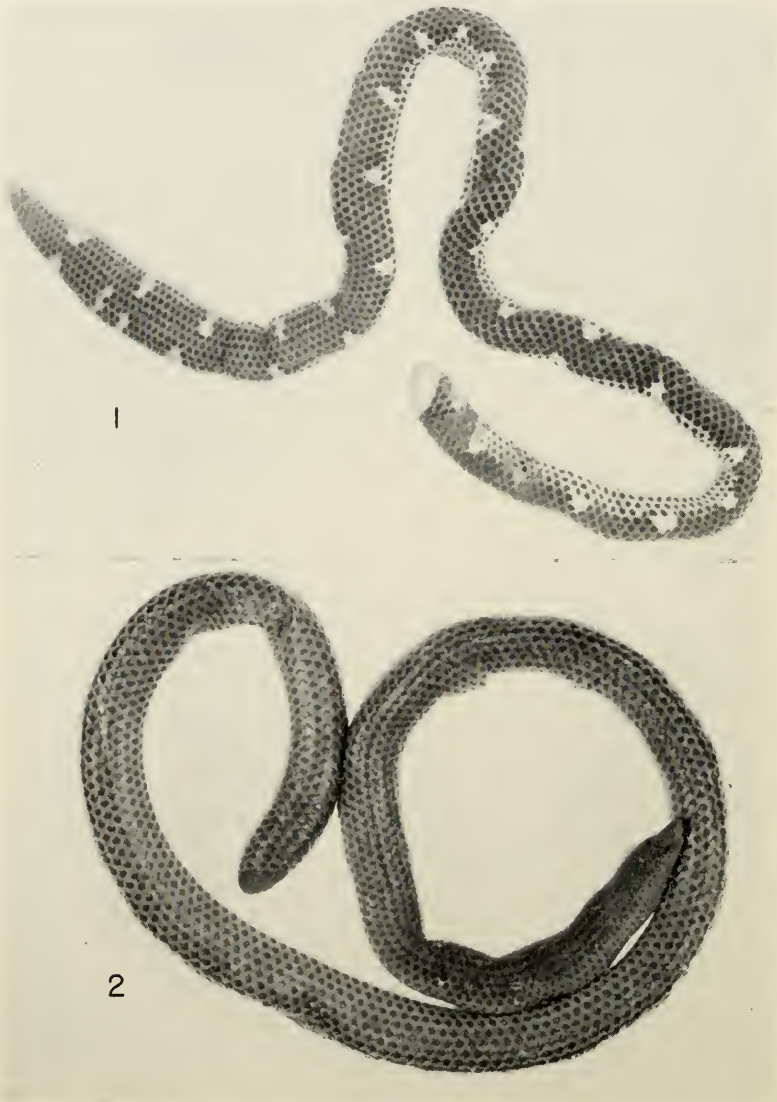


PLATE XII. Fig. 1. *Rhinophis homolepis* Hemprich. U.S.N.M. No. 56430; "Ceylon"; total length, 243 mm. Fig. 2. *Rhinophis oxyrhynchus* (Schneider). EHT-HMS No. 31256; 6 mi. north Trincomalee, Eastern Province, Ceylon.

Rhinophis homolepis Hempricht

Pl. XII, fig. 1

Rhinophis homolepis Hempricht, Grundriss der Naturgeschichte, 1820, p. 119 (type locality, Ceylon *fide* Peters); Peters, De Serpentum Familia Uropeltaceorum, 1861, pp. 14-15, pl. 2, fig. 2; Smith, Fauna of British India . . ., Reptilia and Amphibia, vol. 3, Serpentes, 1943, pp. 90-91.

Dapatnaya trevelyana Kelaart, Prodromus fauna Zeylanicae, vol. 2, pt. 1, 1854, p. 17 (type locality, Kandyan Hills).

Mitylia or *Mytilia Gerrardi* Gray, Proc. London Zool. Soc., vol. 26, 1858, pp. 58, 263, pl. 13 (type locality, Ceylon).

A specimen in the collection (U. S. Nat. Mus. No. 56430) from "Ceylon" has the following scale characters: Ventrals 197, somewhat enlarged; 3 subcaudals; anal divided; scale formula, 19-17.

The head is diminutive, the shielded part being shorter than the terminal caudal plate. There are 23 lateral white spots, the largest of which are on the neck. The postanal shield is white. The species is known from Central Province, Uva Province, and Sabaragamuwa Province.

Rhinophis dorsimaculatus Deraniyagala

Rhinophis dorsimaculatus Deraniyagala, Journ. Bombay Nat. Hist. Soc., Dec., 1941, pp. 800-802, pl. and text fig. 1 (type locality, Marichchukate, Northwest Province, Ceylon); Smith, Fauna of British India . . ., Reptilia and Amphibia, vol. 3, Serpentes, 1943, p. 526.

This recently described species is known from the two type specimens, which were found in the arid part of Ceylon in the north. It is characterized by a broad dorsal orange stripe with small dorsal spots. The total length of the largest specimen is 350 mm. The ventrals are 238 and the scales are in 17 rows.

GENUS UROPELTIS Cuvier

Uropeltis Cuvier, Règne Animal, 2d ed., 1829, vol. 2, p. 76 (part).
Genotype, *ceylanicus*.

Two forms of the genus occur in Ceylon.

KEY TO THE SPECIES OF UROPELTIS IN CEYLON

1. Ventrals 141-166; belly black; dark brown above with an irregular lateral stripe, *melanogaster*

   Ventrals 197-210; bluish gray, with 7 median dorsal rows bearing yellow longitudinal lines made of yellow dots; a lateral series of yellow bars..... *phillipsi*

Uropeltis melanogaster (Gray)

Mytilia (Crealia) melanogaster Gray, Proc. Zool. Soc. London, 1858, p. 264, fig. 5 (type locality, Ceylon).

Uropeltis melanogaster Smith, Fauna British India . . ., Reptilia and Amphibia, vol. 3, 1943, pp. 86-87.

Four specimens of this species are at hand: U. S. Nat. Mus. Nos. 7134, 56397, 56398, 56400. All are from "Ceylon." The species is known from Central Province.

SCALE COUNTS OF *Uropeltis melanogaster*

Number	Sex	Scale rows	Ventrals	Subcaudals	Total length mm.	Tail mm.
7134	♀	19-17	167	6	220	7
56397	♂	19-17	160	10—4 wide	144	6.8
56398	♀	19-17	168	7	200	6.6
56400	♂	19-17	160	9—6 wide	145	7

[Ventrals counted from mental.]

The specimens are somewhat variable in color. No. 56398 is blackish brown, the venter even darker but bordered by an extremely ragged cream line, sometimes discontinuous, varying in width and distinctness. No. 7134 is brown, the light stripes less ragged.

The two males are light brown and the ventral surfaces are largely yellowish cream with occasional brownish scales. The ventrals range from 141 to 168 (counting from the mental).

Uropeltis phillipsi (Nicholls)

Silybura phillipsi Nicholls, Ceylon Journ. Sci., B, vol. 12, 1929, p. 153; and *idem*, D, II, 1929, p. 97 (type locality, Menakanda Group, E Matale Hills, Ceylon).

Uropeltis phillipsi Smith, Fauna British India . . ., Reptilia and Amphibia, vol. 3, 1943, p. 81.

This form is known only from the type locality and Mouskandy Hills, Gammadura, according to Smith.

GENUS PSEUDOTYPHLOPS Schlegel

Pseudo-typhlops (in part) Schlegel, Abbildungen neuer oder unvollständig bekannter Amphibien, 1838, p. 40 (type *philippinus* [*fide* M. Smith, *loc. cit.*]).

A single species known. It is endemic in Ceylon.

Pseudotyphlops philippinus (Cuvier)

Uropeltis philippinus Cuvier, Règne Animal, 2d ed., vol. 2, 1829. p. 74 (type locality, "Phillippines" *ex errore*); Müller, Tiedemann and Treviranus, Zeitsch. für Physiol., vol. 4, pl. 22, figs. 2-3 Gervais Guérin Mag. Zool., 1837, Cl. 3, pl. 13; Duméril, Bibron and Duméril, Erpétologie Générale, vol. 7, 1854, pp. 161-163, Atlas, pl. 59, fig. 2 (see considerable synonymy); Peters, De Serpentum Familia Uropeltaceorum, Berolini, 1861, p. 20.

Pseudotyphlops philippinus Schlegel, Abbildungen neuer oder unvollständig bekannter Amphibien, 1838, p. 44; Smith, Fauna British India . . ., Reptilia and Amphibia, vol. 3, 1943. pp. 93-94, fig. 27.

Uropeltis grandis Kelaart, Prodromus Faunae Zeylanicae, vol. 2, 1854, p. 15 (type locality. Kerinday, near Matura, South Province, Ceylon).

Uropeltis saffragamus Kelaart, Prodromus Faunae Zeylanicae, vol. 2, 1854, p. 15 (type locality, Ratnapoora near Adams Peak, Ceylon).

Uropeltis pardialis Kelaart, Prodromus Faunae Zeylanicae, vol. 2, 1854, p. 16 (type locality, Matura, Ceylon).

The collection contains no specimens belonging to this species. It is a large species of the family, reaching a length of 285 mm. and a diameter of 22 mm., the latter measurement being much larger than that of any other member of the family. The species is dark brown to blackish above, the young having yellow spots. Yellow beneath, the young with dark brown spots on venter.

A lowland form for the most part.

FAMILY ANILIIDAE

GENUS CYLINDROPHIS Wagler

Cylindrophis Wagler, Icon. Amphib., 1828, p. 5.
Genotype, *resplendens*.

One species occurs in Ceylon.

Cylindrophis maculatus (Linnaeus)

Anguis maculata Linnaeus, Museum Regis Adolphi Friderici, p. 21, pl. 21, fig. 3 (type locality, "America"); and Systema Naturae, vol. 1, 10th ed., 1758, p. 228.
Cylindrophis maculatus Wall, Ophidia Taprobanica or the Snakes of Ceylon, 1921, pp. 18-21, figs. 5-6.

The species is said to be common in Ceylon in the plains and in the hills at low elevations. There are no specimens in the collection.

FAMILY BOIDAE

SUBFAMILY PYTHONINAE

Two genera, each represented by a single species, occur in Ceylon.

KEY TO THE GENERA OF THE BOIDAE IN CEYLON

Teeth on the premaxilla; anterior labials and rostral pitted..... *Python*
No premaxillary teeth; rostral and labials not pitted..... *Eryx*

GENUS PYTHON Daudin

Python Daudin, Mag. Encycl., Mar. 1803 (an 8), p. 434.
Genotype, *Python molurus*.

Python molurus Pimbura (Deraniyagala)

Pl. XIII, fig. 1

Python molurus pimbura Deraniyagala, Spolia Zeylanica, vol. 24, pt. 2, 1945, p. 105 (Colombo, Ceylon).

EHT-HMS Nos. 31258 yg.; 31259 yg.; 31260 (head only).

The presence of *Python molurus* has long been known in Ceylon. It is one of the more common snakes of the country. Two specimens were found fifteen miles north of Trincomalee on a tiny islet about one and one half miles offshore. One was dead beside a small rock pool of fresh water having been recently killed, presumably by fishermen. The second specimen was found submerged in another fresh water pool containing much algae. The tip of the snout extended above the surface amid the algae, near the edge. Since the dead specimen had recently fed on a wood pigeon, it was suspected that the snakes caught their prey as the birds drank in the fresh water pools. This was the only species of land snake obtained on the island. Numerous land birds were accustomed to fly over to the island daily and the snake population was assured of a regular food supply about the fresh water pools in the rocks.

Scale counts of Nos. 31258 and 31259 respectively: Ventrals 248, 233; anal 1-1; caudals 61, 63; scale formula 55-64-41, 55-59-38.

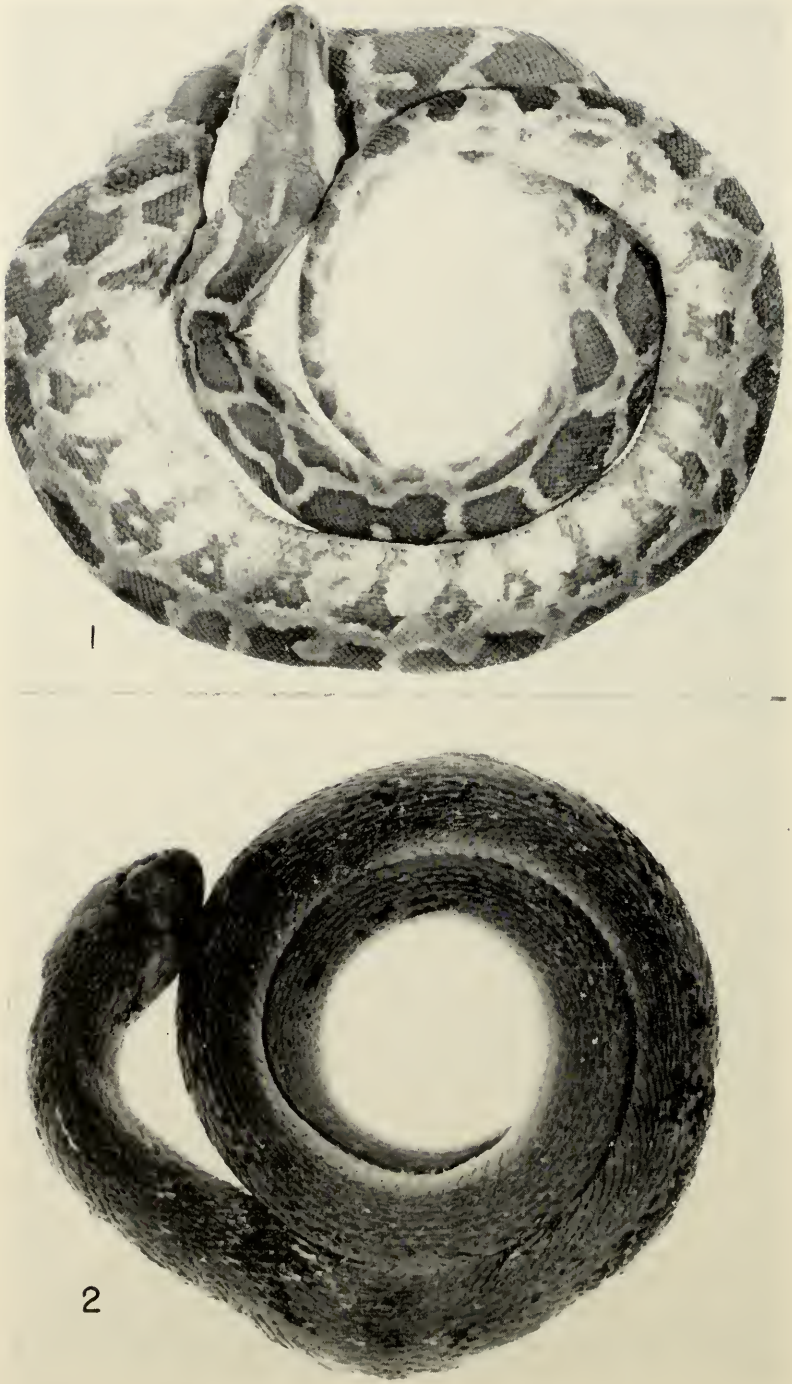


PLATE XIII. Fig. 1. *Python molurus pimbura* Deraniyagala. EHT-HMS No. 31258, yg.; 12 miles north Trincomalee, Eastern Province, Ceylon; total length, 612 mm. Fig. 2. *Macropisthodon plumbicolor* (Cantor). EHT-HMS No. 30681 ♀; 50 mi. S Anuradapura, Ceylon; total length, 627 mm. (The characteristic head and neck markings were visible before the loss of the outer epidermis).

GENUS ERYX Daudin

Eryx Daudin, Mag. Encycl., vol. 5, 1803, p. 437.
Genotype, *turcicus*.

Eryx conicus (Schneider)

Boa conica Schneider, Historia Amphibiorum naturalis et literaria Jena 1799-1801, vol. 2, p. 268; Denkschr. Akad. München, vol. 7, 1821, p. 119, pl. 4, fig. 2 (based on Russell's Indian Serpents, vol. 1, p. 4, pl. 4 [Madras]).

Eryx conicus Deraniyagala, Ceylon Journ. Sci., B, vol. 19, 1936, p. 335, fig.; Smith, The Fauna of British Indian, Ceylon and Burma including the whole of the Indo-Chinese subregion; Reptilia and Amphibia, vol. 3, Serpentes, 1943, p. 112-113, fig. 35.

No specimens of the sand boa are in the collections. It is regarded as a rare snake in Ceylon.

FAMILY COLUBRIDAE

Four subfamilies of the family Colubridae are represented in Ceylon. These are:

Acrochordinae, genus *Acrochordus*.

Homalopsinae, genus *Hurria*.

Sibynophiinae, genus *Sibynophis*.

Colubrinae, genera *Elaphe, Ptyas, Coluber, Liopeltis, Oligodon, Ahaetulla, Crysopelea, Lycodon, Cercaspis, Dryocalamus, Aspidura, Haplocercus, Dryophis, Boiga, Natrix, Balanophis, Macropisthodon,* and *Atretium*.

KEY TO THE SUBFAMILIES OF CEYLONESE COLUBRIDAE

1. Dentary free behind, attached to articulare anteriorly; maxillary teeth 30 to 50. Head with large symmetrical shields: no grooved teeth ..... *Sibynophiinae*
   Dentary not free behind; maxillary teeth usually less than 35 2
2. Head covered with small granular scales; no widened ventral scales; body covered with loose skin; eyes more dorsal than lateral; posterior maxillary teeth not grooved ..... *Acrochordinae*
   Head covered with enlarged regular shields; teeth grooved or not 3
3. Nostril crescentic, on dorsal surface of the snout; rostral without the normal deep excavations for tongue protrusion; eye small, directed upward; last two or three maxillary teeth grooved; salt or fresh water snakes ..... *Homalopsinae*
   Nostril not crescentic, not on dorsal surface of snout; rostral with excavations for tongue extrusion; eyes lateral, directed outward; maxillary teeth with or without grooves ..... *Colubrinae*

SUBFAMILY ACROCHORDINAE

Acrochordinae Boulenger, Catalogue of the Snakes in the British Museum, vol. 1, 1893, p. 172 (part); Smith, The Fauna of British India . . ., Reptilia and Amphibia, vol. 3, Serpentes, 1943, p. 131.

M. Smith, *loc. cit.*, has united the two genera *Acrochordus* and *Chersydrus* into the single genus *Acrochordus*, stating that he did not regard the presence of the ventral abdominal fold a character of sufficient importance to warrant the retention of *Chersydrus*.

GENUS ACROCHORDUS Hornstedt

Acrochordus Hornstedt, Abh. Acad. Stockholm, 1787, vol. 8, p. 307.
Genotype, *Acroohordus javanicus.*

Acrochordus granulatus (Schneider)

Hydrus granulatus Schneider, Historia Amphibiorum naturalis et literaria, vol. 1, 1799, p. 243 (type locality, India).

Acrochordus granulatus Shaw, General Zoology, vol. 3, 1802, p. 576, pl. 130; Smith, The Fauna of British India . . ., Reptilia and Amphibia, vol. 3, Serpentes, 1943, pp. 134-135

No specimens in the collection.

SUBFAMILY SIBYNOPHINAE

Two genera are known.

GENUS SIBYNOPHIS Fitzinger

Sibynophis Fitzinger, Systema Reptilium, 1843, p. 26.
Genotype, *Herpetodryas geminatus* Schlegel.

Taylor and Smith* have separated the Mexican and Central American species of this subfamily into a separate genus, *Scaphiodontophis.*

The range of the genus *Sibynophis* includes Madagascar, Comoro Islands, Ceylon and south Asia from India to China. There are ten valid species known.

Sibynophis subpunctatus (Duméril, Bibron and Duméril)

Pl. XIX, fig. 1

Oligodon subpunctatum Duméril, Bibron and Duméril, Erpétologie Générale, vol. 7, 1854, p. 58 (type locality, "Malabar").

Polyodontophis subpunctatum Boulenger, Fauna British India including Ceylon and Burma, Reptilia and Batrachia, 1890, p. 303 (Ceylon); Catalogue of the Snakes in the British Museum, vol. 1, 1893, pp. 186-187; Abercromby, Spolia Zeylanica, vol. 8, pt. 32, Jan., 1913, pp. 304-305 (Colombo, Matale, Kalutara); Wall, Ophidia Taprobanica or the Snakes of Ceylon, 1921, pp. 84-89, fig. 20 (Colombo; Neboda near Kalutara; Puttalam; Galatura Estate Colombo; Ratnapura District, 1,000 ft.).

Enicognathus humberti Jan, Arch. Zool. Anat. Fis., vol. 2, fasc. 2, Mar. 31, 1863, p. 65; Elenco systematico degli Ofidi, 1863, p. 50 ("Trincomalie, Ceylan"); L'Iconographie Générale des Ophidiens, livr. 16, 1866, pl. 4, fig. 1 ("Trincomalie, Ceylan").

EHT-HMS Nos. 31251-31253, 12 miles north of Trincomalee; U. S. Nat. Mus. No. 56231.

This small species has long been known from Ceylon. It is probably not a rare snake but its dimunitive size prevents it appearing commonly in collections. Two specimens were taken moving about at night, and one was found concealed below a small log in the day time.

* Univ. Kansas Sci. Bull., vol. 29, pt. 2, no. 6, pp. 302-304.

The squamation characters follow: EHT-HMS 31252. Rostral visible above for a distance equal to half the length of the internasals; latter, two thirds the length of prefrontals; frontal a third longer than its distance from snout tip, the sides not angular; parietals large, their length equal to their distance from rostral; nasal divided; loreal longer than high; one preocular, two large postoculars; two anterior temporals, the lower widely separated from the postoculars, wedged between the seventh and eighth labial; temporal formula $2+\frac{1}{2}$; supralabials 9-9, in the following order of size: 1, 5, 4, 3, 2, 6, 7, 8, 9; infralabials 10-10, four touching the first chinshields; 2 pairs of chinshields, subequal.

Scale formula, 17-17-17; ventrals 170, anal divided; subcaudals (divided) 32 (tail with a part missing).

The ventral and subcaudal counts for EHT-HMS Nos. 31234 ♂ and 31235 ♂ respectively are: 157, 163; 58, 66.

The ventral and subcaudal variation is large in this species. Smith, *loc. cit.*, gives for the Ceylon and South Indian (south of latitude 14°) specimens, 157-200 ventrals; India north of latitude 18°, 172-215 ventrals. The all-over count of males, 60-70 subcaudals, for females, 54-63.

Head dark brownish, a cream white spot covering most of each supralabial; a lighter band between the posterior part of eyes, which connects with two lighter irregular marks running above eyes and on canthus to rostral; a well-defined cream bar on each side of head crossing ninth supralabial and passing up covering extreme tips of parietals. These bars separated medianly by a narrow black longitudinal line; behind these bars, four to six scale rows, a transverse cream band, only partially interrupted mesially. The dorsal color is brownish produced by a peppering of pigment on a lighter background; a median row of darker punctations often outlined in cream; on the posterior part of the body a line formed of short cream dashes is discernible on the fourth and (more posteriorly) fifth scale rows. A dark spot on ends of the ventrals and subcaudals distinct throughout entire length on males, somewhat less distinct in the female.

The species is confined largely to the lowland and hill areas in Ceylon and is seemingly a rare snake.

KEY TO THE CEYLONESE GENERA OF THE COLUBRINAE

1. All maxillary teeth solid, lacking grooves 5
   Posterior maxillary teeth (usually two to four) with grooves 2
2. Pupil round 3
   Pupil vertical or horizontal 4
3. Solid maxillary teeth 24-26, subequal; posterior fangs large; head distinct from neck; scales strongly keeled save outer row; ventrals rounded; a nuchal gland; scale rows 19 around middle of body ..... *Balanophis*
   Maxillary teeth 20-22, the last three or four feebly enlarged and grooved; scales smooth or feebly keeled; scales in 17 rows ..... *Chrysopelea*
4. Pupil vertical; body more or less compressed; scales smooth, in 19-29 rows, the vertebral scales often enlarged; 10 to 14 maxillary teeth, followed by two or three enlarged grooved fangs ..... *Boiga*
   Pupil horizontal; maxillary teeth 12, the anterior six or seven teeth gradually enlarged (or last two abruptly enlarged); these followed after an interspace, by a series of seven small teeth, and these in turn followed by two much enlarged grooved fangs ..... *Dryophis*
5. Hypapophyses absent on the posterior dorsal vertebrae, the lower surface of which is smooth or with a very low keel 6
   Hypapophyses developed throughout the vertebral column represented by a distinct crest or keel or a tubercle 15
6. Posterior maxillary teeth longer than anterior 7
   Posterior maxillary teeth not longer than anterior 11
7. Pupil round 8
   Pupil vertical; six to ten maxillary teeth; scales in 13 or 15 rows, smooth; the ventrals angulate ..... *Dryocalamus*
8. Scales in an even number of rows throughout body, 14-18, smooth or slightly keeled; teeth 20-23; a presubocular present ..... *Zaocys*
   Scales in odd number of rows or, at least, odd numbers on anterior part of body .. 9
9. Last two maxillary teeth separated by an interval from rest of series; maxillary teeth 12-18, increasing in size; a subocular (rarely absent); 21 to 23 scale rows about middle of body; large snakes of more than a meter length ... *Coluber*
   Last two maxillary teeth not separated by an interval 10
10. Maxillary teeth 20-28, forming a continuous series; scales often in even numbers on latter half of body; two or three (rarely four) loreals; large snakes 2 meters or more in length ..... *Ptyas*
    Maxillary teeth 6 to 16, the posterior strongly enlarged and compressed; scales in 13-21 rows; rostral large; scales smooth; small snakes, less than a meter in length ..... *Oligodon*
11. Pupil round; none of the anterior maxillary teeth enlarged, the series not broken by an interval; maxillary bone not strongly arched 12
    Pupil vertically elliptic; some of the anterior maxillary teeth enlarged and fanglike; maxillary strongly arched 14
12. Scales in 19-27 rows, with apical pits ..... *Elaphe*
    Scales less than 19 rows; apical pits present or absent 13
13. Scales 13-17 rows, the vertebrals not enlarged, without apical pits ..... *Liopeltis*
    Scales 13-15, rows disposed in oblique transverse rows, with enlarged vertebrals, apical pits present ..... *Ahaetulla*
14. Scales in 15 or 17 rows, smooth or feebly keeled; subcaudals divided ..... *Lycodon*
    Scales in 19 rows, strongly keeled, subcaudals single ..... *Cercaspis*
15. Posterior maxillary teeth longest; head distinct from neck; loreal present; one or two internasals 16
    Maxillary teeth subequal; head not distinct from neck; scales in 15-17 rows; no loreal; internasal single 18
16. Two internasals; nostrils lateral; scales in 20-25 rows, strongly keeled 17
    One internasal; nostrils directed upward and outward, scales in 19 rows at midbody ..... *Atretium*
17. Maxillary teeth 20 to 35; posterior teeth not fanglike; scales in 15-19 rows ... *Natrix*
    Maxillary teeth 11 to 18, followed by two very large fangs; scales in 25 to 27 rows ..... *Macropisthodon*
18. Maxillary teeth, 20-24; scales 15-17 rows; heavy spines on sides in anal region in ♂ ..... *Aspidura*
    Maxillary teeth 10-12; scales in 17 rows; no lateral spines in anal region .. *Haplocercus*

GENUS ELAPHE Fitzinger

Elaphe Fitzinger, in Wagler's Icon. Desc. Amphib., pt. 3, 1828, text to plate 27 (*fide* M. Smith).

Genotype, *parreysi* = *quatuorlineatus*.

A single species of the genus occurs in Ceylon.

Elaphe helena (Daudin)

Pl. XIV

Coluber helena Daudin, Histoire Naturelle des Reptiles, vol. 6, year 11 = 1803 (based on Russell's plate, Hist. Nat. of Indian Coromandel Serpents, pl. 32); Pearless, Spolia Zeylanica, vol. 6, pt. 21, 1909, pp. 55 (Badulla, 2,222 ft. elev.); Wall, Ophidia Taprobanica . . ., 1921, pp. 197-203, fig. 42 ("a common up country snake," Colombo).

Cynophis bistrigatus Gray, Ann. Mag. Nat. Hist., ser. 2, vol. 4, p. 246 (type locality, Ceylon).

Elaphe helena Shaw, Shebbeare and Barker, Journ. Darjeeling Nat. Hist. Soc., vol. 14, 1939, p. 78; Smith, The Fauna of British India . . ., Reptilia and Amphibia, vol. 3, Serpentes, 1943, pp. 149-152.

Wall, *loc cit.*, suspects that the Colombo record might be accounted for by an importation from the hills. However, I collected a specimen 12 miles north of Trincomalee at near sea level and another was seen. It was said to be "not rare" in the area.

The specimen EHT-HMS 30680 ♀ has the following scale characters: Color of head lavender to fawn-brown with a black line following the parietal suture and a diagonal line behind eye; a black spot on upper edge of last supralabial. On body, lavender-brown with a pair of black lines beginning just back of the parietals and passing back on the neck for about an inch. Here they become indistinct but can be dimly traced some distance further. A diagonal line on the side of the neck beginning five or six scale lengths back of the jaw angle and terminating on the end of the tenth ventral; a series of indefinite dark blotches follow the lines, the "spots" consisting largely of dark outlines on the scales contiguous laterally with a light spot on the fifth and sixth scale rows and one on the first, second and third scale rows, the two light spots at least partially outlined with black; about one third of the length back of head the blotches become almost or completely obsolete; but a broad dark line, scarcely noticeable on the anterior half of the body becomes more distinct on the latter half of body and tail, covering most of the second to fifth rows of scales, reduced to a single scale row on tail. Below uniform yellow cream.

The scale formula is 29-27-21; ventrals 235; anal single; subcaudals 86. The known ventral range is from 217-265; subcaudals 73-100, according to Smith, *loc. cit.*

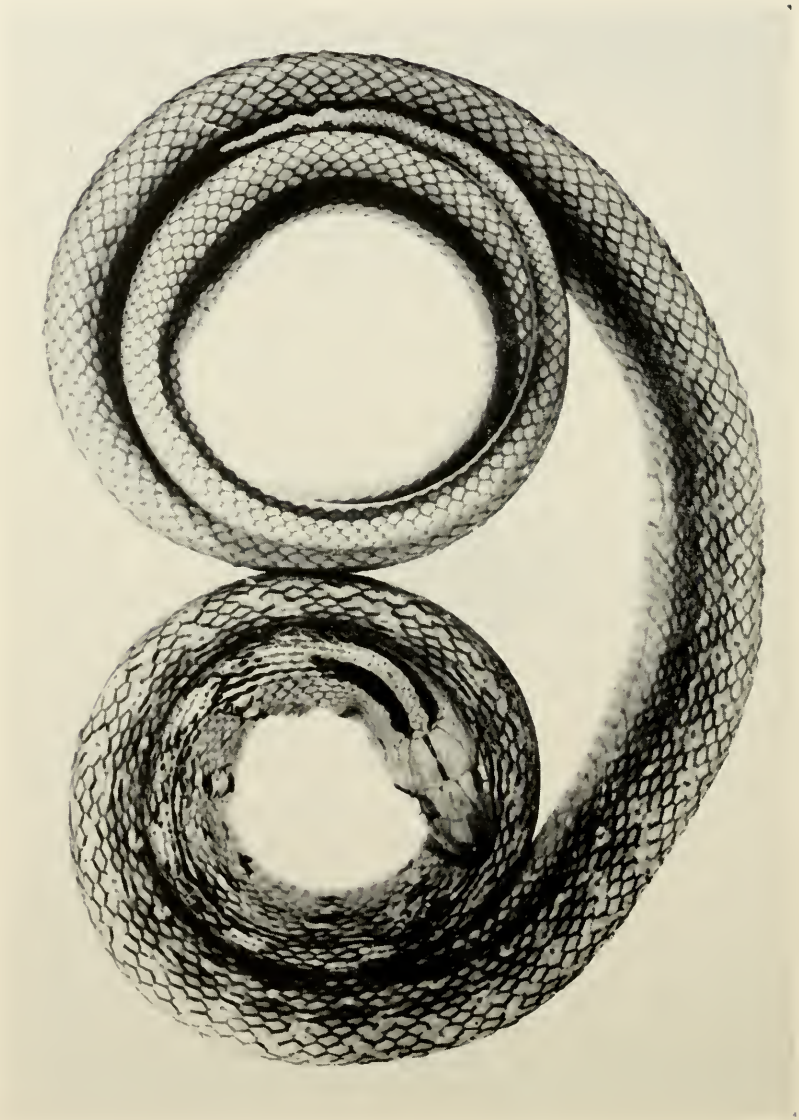


PLATE XIV. *Elaphe helena* (Daudin) ♀. EHT-HMS No. 30680; 12 miles north of Trincomalee, Eastern Province, Ceylon; total length, 1,135 mm.

TABLE OF DATA ON CEYLONESE SPECIMENS OF *Ptyas mucosus*

Number	Sex	Ventrals	Sub-caudals	Loreal	Scale formula	Pre-oculars	Post-oculars	Supra-labials	Infra-labials	Temporals	Labials enter eye
30696	♂	201	141	3–3	21, 17, 14, 14	2–2	2–2	8–8	9–11	2 + 2	4th and 5th
30697	♂	197	139	3–3	21, 17, 14, 14	2–2	2–2	8–8	10–10	$\frac{2}{1}$ + 2	4th and 5th
30698	♂	204	139	2–2	21, 17, 17, 14	2–2	2–2	8–8	10–10	2 + 2	4th and 5th
30699	♂	200	133	3–3	19, 17, 16, 14	2–2	2–2	8–8	11–11	2 + 2	4th and 5th
30700	♀	207	146	4–4	21, 17, 14, 14	2–2	2–3	8–8	10–10	2 + 2	4th and 5th
30701	♀	206	141	3–2	21, 17, 16, 14	2–2	2–2	8–8	10–10	2 + 2	4th and 5th

GENUS PTYAS Fitzinger

Ptyas Fitzinger, Systema Reptilia, 1843, p. 26.
Genotype, *Coluber blumenbachi*.

One species occurs in Ceylon. It is a large snake reaching approximately two meters in length when full grown.

Ptyas mucosus (Linnaeus)

Pl. XV, fig. 1

Coluber mucosus Linnaeus, Museum Adolphi Friderici regis, vol. 1, p. 37, pl. 23; Systema Naturae, ed. 10, 1758, p. 226 (type locality, India).
Ptyas mucosus Günther, Reptiles of British India, 1864, p. 249.

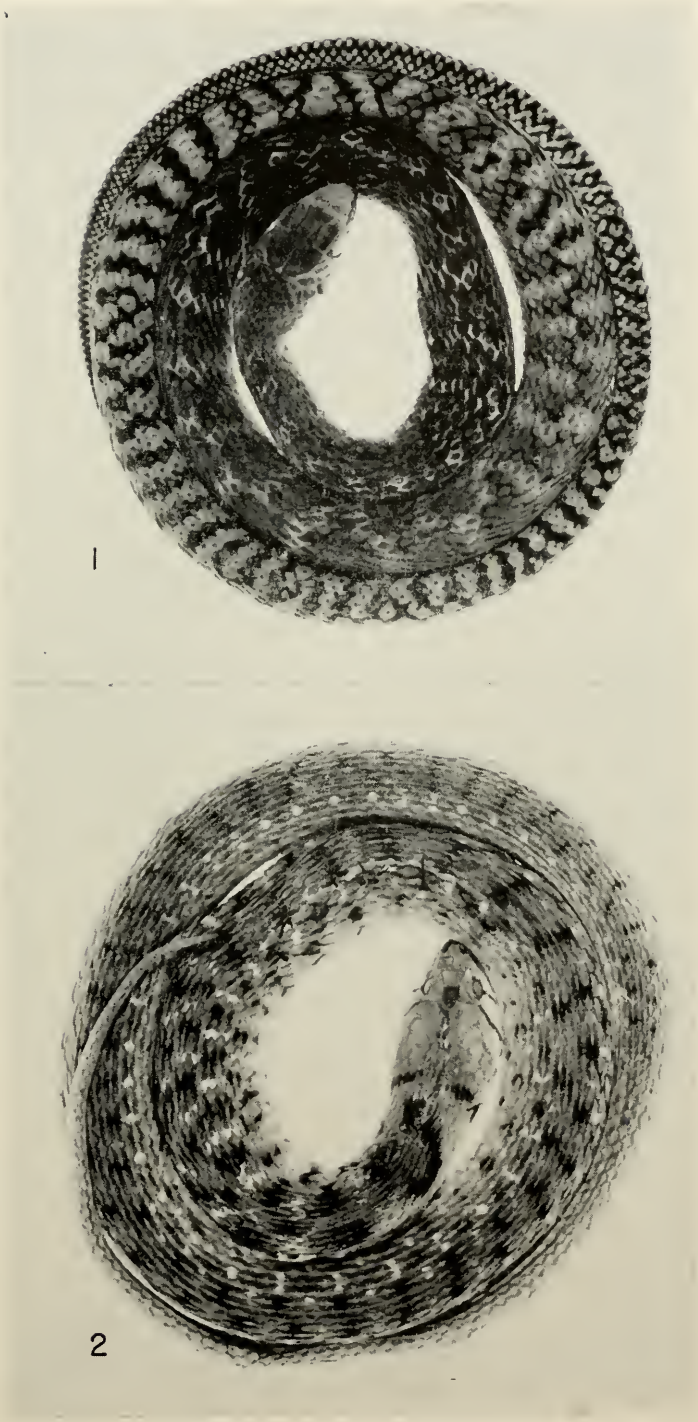
The collection contains the following specimens of this species: EHT-HMS Nos. 30696-30701, 12-13 miles north of Trincomalee, Ceylon; U.S.N.M. No. 56198, Ceylon.

These apparently agree with specimens from the mainland of India in most characters of squamation and in color markings.

The markings of the anterior part of the body are poorly defined. The skin between the scales is whitish, which color sometimes encroaches on the scales a little. Thus a whitish reticulation is evident when the scales are distended but only a trace of it is visible when scales are normally imbricated. The posterior part of body has numerous transverse black bands, the edges of which are irregular.

The character of the scale rows is unusual in this genus. The scale rows across the back part of head are 25-27, while the number of rows on the posterior part is reduced to 14. On the anterior part of the body, the scale rows are in odd numbers around the body while in the posterior part of the body they are in even numbers. This is accomplished by replacing the median single row with paired scales. In a related genus, *Zaocys*, this occurs throughout the length of the body. Even numbers of scale rows is a rare condition in snake genera. (See preceding page for table of scale data).

PLATE XV. Fig. 1. *Ptyas mucosus* (Linnaeus). EHT-HMS No. 30689 ♀ ; 12 miles north Trincomalee, Eastern Province, Ceylon; total length, 795 mm. Fig. 2. *Natrix piscator* (Schneider). EHT-HMS No. 30730 ♀ ; 12 miles north of Trincomalee, Eastern Province, Ceylon; total length, 745 mm.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GENUS COLUBER Linnaeus

Coluber Linnaeus, Systema Natura, ed. 10, 1758, p. 216.
Genotype, *Coluber constrictor*.

Only a single species has been recorded for Ceylon.

Coluber fasciolatus Shaw

Coluber fasciplatus Shaw, General Zoology, vol. 3, p. 528 (Based on Russell, An Account of Indian Serpents, vol. 1, 1796, p. 26, pl. 21, India).
Zamenis fasciolatus Wall, Ophidia Taprobanica . . ., 1921, pp. 191-195, fig. 41 (Jaffna).

No specimen in the collection.

A specimen of this species has been reported by Haly from Jaffna. Since this record may be due to faulty data, this form must be regarded as a doubtful resident of Ceylon.

GENUS LIOPELTIS Fitzinger

Liopeltis Fitzinger, Systema Reptilium, p. 26.
Genotype, *Herpetodryas tricolor* Schlegel.

One species occurs in Ceylon.

Liopeltis calamaria (Günther)

Cyclophis calamaria Günther, Catalogue of the Colubrine Snakes in the Collection of the British Museum, 1858, p. 250 (type locality, Ceylon).
Liopeltis calamaria Wall, Ophidia Taprobanica . . ., 1921, p. 251, fig.; Smith, The Fauna of British India . . ., Reptilia and Amphibia, vol. 3, Serpentes, 1943, pp. 184-185.

No specimen of this species is represented in the collections.

This form may be identified by the following characters: Scale formula 15-15-15; an elongate undivided nasal scale; supralabials 7-7, infralabials 7-7. The ventrals of Ceylonese specimens vary between 127-134; the subcaudals between 67-76.

Olive-green dorsally with a fine blackish line along the edge of the fifth and sixth scale rows, the line tending to break up into spots anteriorly and continuing well on the tail. Another dark line, less distinct, follows the edges of the third and fourth scale rows. Belly pale yellow. Some specimens show lighter stripes. Maximum length, 407 mm.

GENUS OLIGODON Boie

Oligodon Boie, Isis, 1827, p. 519.
Genotype, *Oligodon bitorques*.

The following five forms of *Oligodon* are recognized as occurring in Ceylon: *O. sublineatus, O. calamarius, O. taeniolatus fasciatus, O. t. ceylonicus,* and *O. arnensis.*

KEY TO THE FORMS OF OLIGODON IN CEYLON

1. Ventral scales with three brown spots forming continuous lines; small paired dorsal spots sometimes alternating; no palatine teeth, 4-6 pterygoid teeth; ventrals, ♂ 130-144, ♀ 149-160; subcaudals, ♂ 32-36, ♀ 23-30..... *sublineatus*
   Venter lacking distinct lines 2

2. Venter with squarish white and black spots; a median dorsal white line and 18 narrow cross bars; ventrals, ♂ 127-138, ♀ 143-152; subcaudals, ♂ 28-34, ♀ 20-24; palatine and pterygoid almost or completely edentulous..... *calamarius*
   Venter lacking squarish black and white spots; few pterygoid teeth..... 3
   Venter white; pterygoid teeth numerous (15-17)..... *arnensis*
3. A more or less buff species with two broad dark-brown dorsal lines, separated by a whitish median line; a narrow dark line from mouth to vent; about 43 dim or diffuse cross bands, each preceded and followed by narrow flecks of white; venter white or flesh color; ventrals, ♂ 171-175, ♀ 184-185; subcaudals, ♂ 45-51, ♀ 44..... *taeniolatus ceylonicus*
   Pale buff or yellowish brown with a median series of rather large, well-defined, rounded dark spots along back (some may be broken medially); ventrals, ♂ 158-159, ♀ 174; subcaudals, ♂ 40-46, ♀ 40..... *taeniolatus fasciatus*

Oligodon arnensis (Shaw)

Pl. XVI, fig. 2; Text fig. 2

Coluber arnensis Shaw, General Zoology, vol. 3, pt. 2, 1802 (type locality, "Country of Arnee in the East Indies") (Based on Russell's Indian Serpents, vol. 2, 1796, pl. 38, Arni, N. Arcot.).

Oligodon albiventer Günther, Reptiles of British India, 1864, p. 213 (near Kandy, Ceylon).

Oligodon arnensis Smith, Fauna of British India . . ., Reptilia and Amphibia, vol. 3, Serpentes, 1943, pp. 225-226, fig. 77.

Oligodon arnensis albiventer Deraniyagala, Ceylon Journ. Sci., ser. B, vol. 20, 1936, p. 89.

A single specimen referable to this species is present in the collection. This is U. S. Nat. Mus. No. 120332, collected at Peradeniya, Kandy District, Ceylon, by H. G. Deignan.

The ground color is a deep gray brown, with 17 transverse white-edged black bands, that terminate laterally on the outer scale row. The venter and most of the outer first row and part of the second row, pearly white. However there is some slight scattering of pigment on the two scale rows. Between the transverse bands are faint traces of intercalated spots. These consist of some black flecks on the sides, and occasionally a few on the back.

A pair of lines run forward from near the second ventral, crossing the angle of the mouth, and meeting on the frontal (or narrowly failing to meet). Two other lines arise on either side above the ninth ventral and run forward. These meet seven scales back of the parietal. A narrow band crosses the base of the snout, involves the eyes and reaches almost to the mouth. Dark flecks are present on the second and sixth labials.

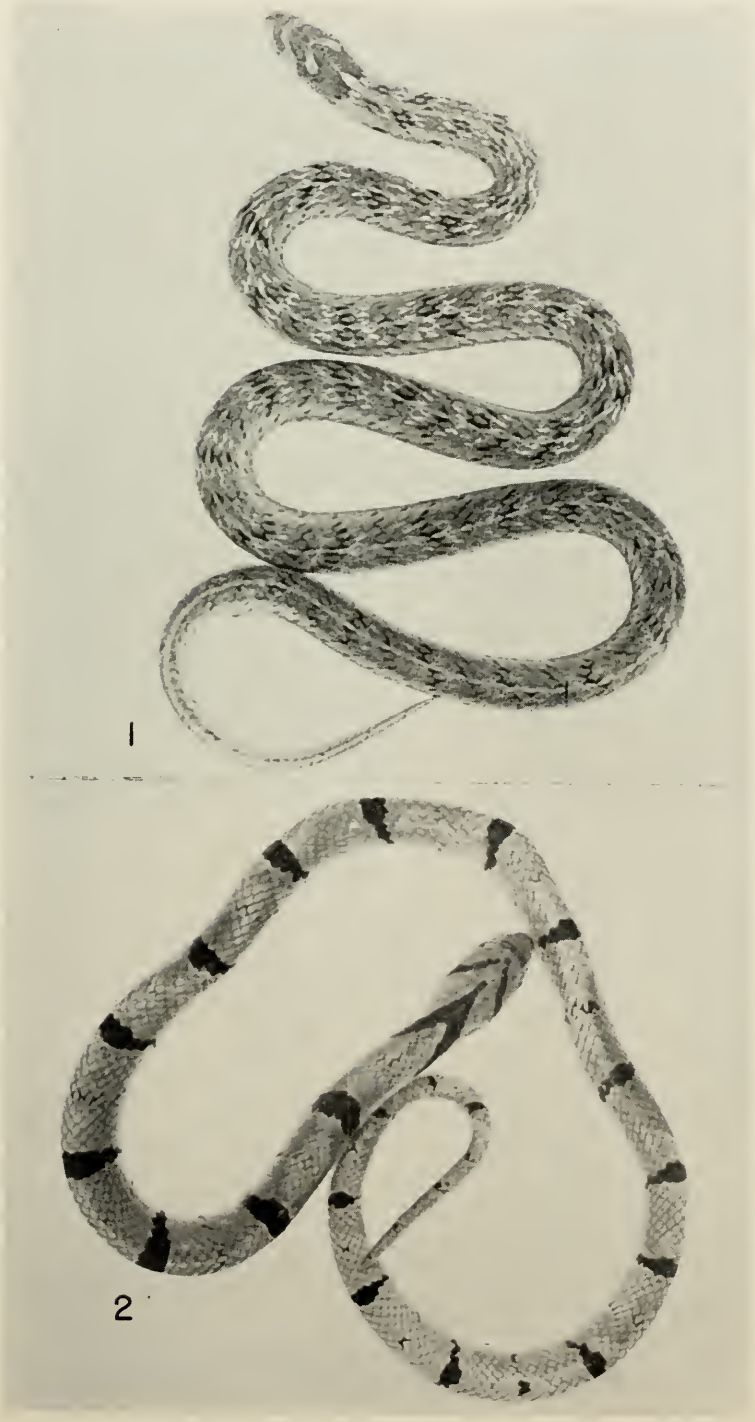
There are eleven maxillary teeth, small anteriorly, the ninth suddenly becoming much larger, followed by two large knifelike teeth. Eight palatine teeth present followed after an interspace by 17 pterygoid teeth. There are 19 teeth on the mandible.

The ventrals number 180, subcaudals 46. The anal is divided. The scale formula is 17-17-15. Total length, 317 mm., tail, 47 mm. The type is said to have 169 ventrals and 50 subcaudals.

FIG. 2. *Oligodon arnensis* (Shaw), U.S.N.M. No. 120332. A. Dorsal view of head. B. Lateral view of head (× 10).

There is a strong probability that Günther's name (*albiventer*) should be applied to this form. Series of specimens alone can verify the relationship.

PLATE XVI. Fig. 1. *Oligodon taeniolatus ceylonicus* Wall. EHT-HMS No. 30167 ♀ ; 12 miles north of Trincomalee, Eastern Province, Ceylon; total length, 370 mm. Fig. 2. *Oligodon arnensis* (Shaw). U.S.N.M. No. 120332 ♀ ; Peradeniya, Kandy District, Central Province, Ceylon; total length, 314 mm.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Oligodon taeniolatus (Jerdon)

Coronella taeniolatus Jerdon, Journ. Asiat. Soc. Bengal, vol. 22, 1853, p. 528 (type locality, doubtful, perhaps based, at least in part, on Russell, 1796, pl. 19, p. 24 [Vizagapatam]).

Oligodon taeniolatus Wall, Ophidia Taprobanica or the Snakes of Ceylon, 1921, pp. 239-245, fig. 50.

At least two subspecies occur in Ceylon: *O. taeniolatus fasciatus* Günther and *O. taeniolatus ceylonicus* Wall.

Oligodon taeniolatus fasciatus (Günther)

Oligodon fasciatus Günther, Reptiles of British India, 1864, pp. 208-209, pl. XIX, fig. D (type locality, Deccan [India]).

Oligodon taeniolatus fasciatus Wall, Ophidia Taprobanica or the Snakes of Ceylon, 1921, pp. 239, 241-242.

Wall, *loc. cit.*, reports this form from Ceylon. I have seen no specimens from there. It may be recognized by the median series of rounded spots which pass down the back, some of the anterior ones being divided. Other lateral marks and small spots are present near the edge of the ventrals.

Oligodon taeniolatus ceylonicus Wall

Pl. XVI, fig. 1

Oligodon taeniolatus (variety) *ceylonicus* Wall, Ophidia Taprobanica or the Snakes of Ceylon, 1921, pp. 240-247.

A series of specimens, EHT-HMS Nos. 30165-30172, from a point 12-14 miles north of Trincomalee, Ceylon, have been examined. One specimen, No. 24138, is in the Kansas University Museum of Natural History. The following table gives scale counts and measurements of the specimens.

SCALE COUNTS AND MEASUREMENTS OF *O. t. ceylonicus*

Number	Sex	Ventrals	Sub-caudals	Scale formula	Total length	Tail length
30165	♂	175	45	19-17-15	414	68
30166	♂	175	47	19-17-15	390	63
30167	♀	185	42	19-17-15	374	55
30168	♂	175	47	19-17-15	384	62
30169	♂	171	45	19-17-15	295	47
30170	♀	184	44	19-17-15	311	42.5
30171	♂	174	51	19-17-15	156	25
30172	♂	174	50	19-17-15	146	23
24138 *	(yg.)	178	36	19-15-15	151	17

* Negombo, Western Province, Ceylon.

The dorsal seven rows are dark brown, traversed by about 43 narrow, darker bands, composed of a series of black brown flecks on scales, each preceded by a series of pure white longitudinal flecks. Sometimes these areas are rather dim, and when broken medially

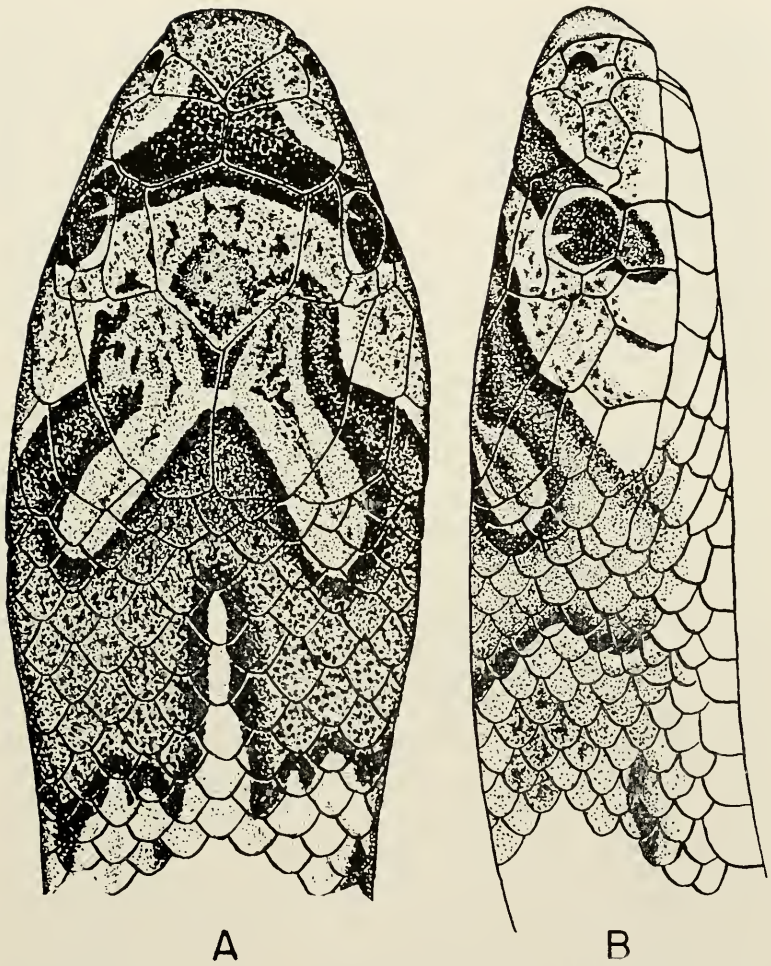


FIG. 3. *Oligodon taeniolatus ceylonicus* Wall. EHT-HMS No. 30167; 12 mi. N Trincomalee, Ceylon. (× 10).

may alternate. Many of the lateral scales may have dark brown, diagonally placed flecks that tend to form lateral diagonal lines.

A well-defined dark band lies across the neck usually sending forward a median tongue and two lateral prongs which nearly enclose two elongate light areas on the back of the head; a dark band crosses the snout and involves the eyes, reaching to the commissure of the mouth. There is a suggestion of a hair-fine, median line occupying the median third of the dorsal scale row, but in none is it continuous. A dim brownish narrow line goes from angle of the

mouth to near the vent, lying largely on the second or third outer scale rows.

The venter is entirely without dark color. The outer fifth of the ventrals are creamy white. Along the edge of this color is a transparent line which together with those on other scales form a longitudinal line on each side of the ventrals. Between these lines the ventrals are flesh color.

The specimens were encountered about rocky outcrops in the forest. Usually they were found coiled under rocks lying partially on other rocks. They were very gentle, permitting themselves to be handled. They did not attempt either to bite or to escape.

The drawing shows the general disposition of head scales.

Oligodon sublineatus Duméril, Bibron and Duméril

Pl. XVII, fig. 1

Oligodon sublineatum Duméril, Bibron and Duméril, Erpétologie Générale, vol. 7, pp. 57-58 (type locality, Ceylon); Smith, Fauna of British India, Ceylon and Burma . . ., Reptilia and Amphibia, vol. 3, Serpentes, 1943, pp. 227-228.

A single specimen, U. S. Nat. Mus. No. 56330, "Ceylon," shows no divergence of significance from the typical. The presence of the dorsal narrow transverse paired spots (which frequently alternate), the three ventral lines of dots (two only on the tail) and the gray-brown dorsal coloration make this form easily recognized. It has been remarked that this form shows a marked superficial resemblance to *Callophis melanurus* (Shaw), which also occurs on the island. The following scale characters obtain in this specimen:

Ventrals, 149; subcaudals, 27; anal divided; 7 upper and 7 lower labials.

The ventral range given by Smith, *loc. cit.*, is 134-161; of subcaudals, 23-37.

Oligodon calamarius (Linnaeus)

Coluber calamarius Linnaeus, Mus. Ad. Frid., 1754, p. 23, tab. 6, fig. 3; and Systema Naturae, 10th edition, 1754, p. 216, and 12th edition, p. 375 (*fide* Andersson, Bihang till k. Svenska vet.-Akad. Handl., bd. 24, Afd. IV, No. 6, 1899, pp. 8-9) (type locality, "America" in error).

Oligodon templetoni Günther, Ann. Mag. Nat. Hist., ser. 3, vol. 9, 1862, p. 57 (type locality, Ceylon); and Rept. British India, 1864, p. 209, pl. XIX, fig. c.

Oligodon calamarius Andersson, *loc. cit.*; Smith, Fauna British India . . ., Reptilia and Amphibia, vol. 3, Serpentes, 1943, pp. 228-229, fig. 78.

No specimens are in the collection. The species is known from numerous localities, occurring from the lowlands to an elevation of 3,000 to 4,000 feet.

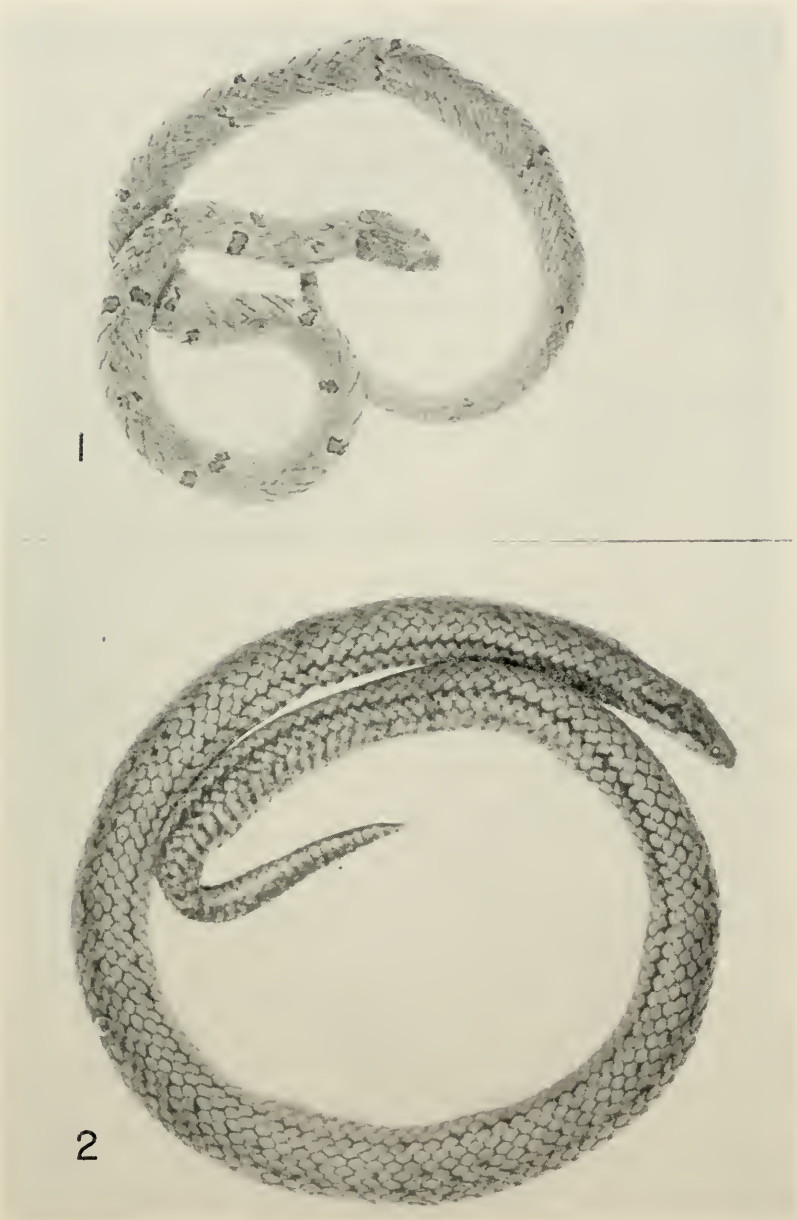


PLATE XVII. Fig. 1. *Oligodon sublineatus* Duméril, Bibron and Duméril. U.S.N.M. No. 56300 ♂ ; "Ceylon"; total length, 260 mm. Fig. 2. *Aspidura trachyprocta* Cope. EHT-HMS No. 30731; "Ceylon"; total length, 316 mm.

GENUS AHAETULLA Link

Ahaetulla Link, Beschreibung der Naturalien-Sammlung der Universität zu Rostock, vol. 2, p. 73.

Genotype, *fasciata* = *Coluber ahaetulla*.

There has been considerable confusion in the application of the generic name *Ahaetulla*.* It is apparent that the name must be applied to a group of oriental snakes rather than to a group of South American forms related but not congeneric with them. It is fitting since the name *Ahaetulla* presumably is based on a Sinhalese word.

Four species of this genus occur in Ceylon. One is here described as new. These may be differentiated by the following characters:

KEY TO CEYLONESE SPECIES OF AHAETULLA

1.	No loreal present; scales in 15 rows; ventrals 175	*oliveri*
	One or more loreals present	2
2.	Two loreals; scales at middle of body in 15 rows; ventrals 154-176	*bifrenalis*
	One loreal; scales in either 13 or 15 rows	13
3.	Scale rows 13; ventrals 149-164	*caudolineolatus*
	Scales in 15 rows; ventrals 163-157	*tristis*

Ahaetulla bifrenalis (Boulenger)

Dendrophis bifrenalis Boulenger, The Fauna of British India, 1890, p. 338 (type locality, Ceylon).

One specimen (EHT-HMS No. 30745) of this rare species was captured 13 miles north of Trincomalee.

It may be identified by the character of the double loreal, and the relatively low ventral count (154-176) and relatively high subcaudal count (144-175). The scale formula is 15-15-11. The vertebrals are strongly enlarged, broader than the outer scale row at midbody, their posterior margin truncate or concave.

No. 30745. The nasal scale differs from that of other members of the genus occurring in the same locality. The nostril is near the middle of a large undivided scale. From the nostril a groove extends back to the anterior loreal which I suspect may actually be a very aberrant posterior nasal. The preoculars are 1-1, the postoculars 2-2. The temporals are $1+2+2$ $(2+1+2)$. Supralabials are 9-9, of which the fifth and sixth border the orbit; infralabials are 10-10, five of which border the anterior chinshield. The eye is large but its diameter is distinctly less than its distance from the nostril. The ventrals are 168, each with lateral keels. There are 145 subcaudals, all of which have keels. There is a divided anal.

* An excellent review of this by Dr. J. Oliver appears in Bull. Amer. Mus. Nat. Hist., vol. 92, 1948, pp. 167-170.

The top of the head is gray. The side of the head bears a black stripe that passes through eye to the neck. Anterior labials are pure cream save on their upper edges. A series of dashlike white marks are present on the first and second scale rows occupying only the adjacent edges of the scales. A series of dark diagonal marks pass across the anterior third of the body, none of which are wider than one scale length.

Ahaetulla oliveri sp. nov.

Pl. XVIII, fig. 1

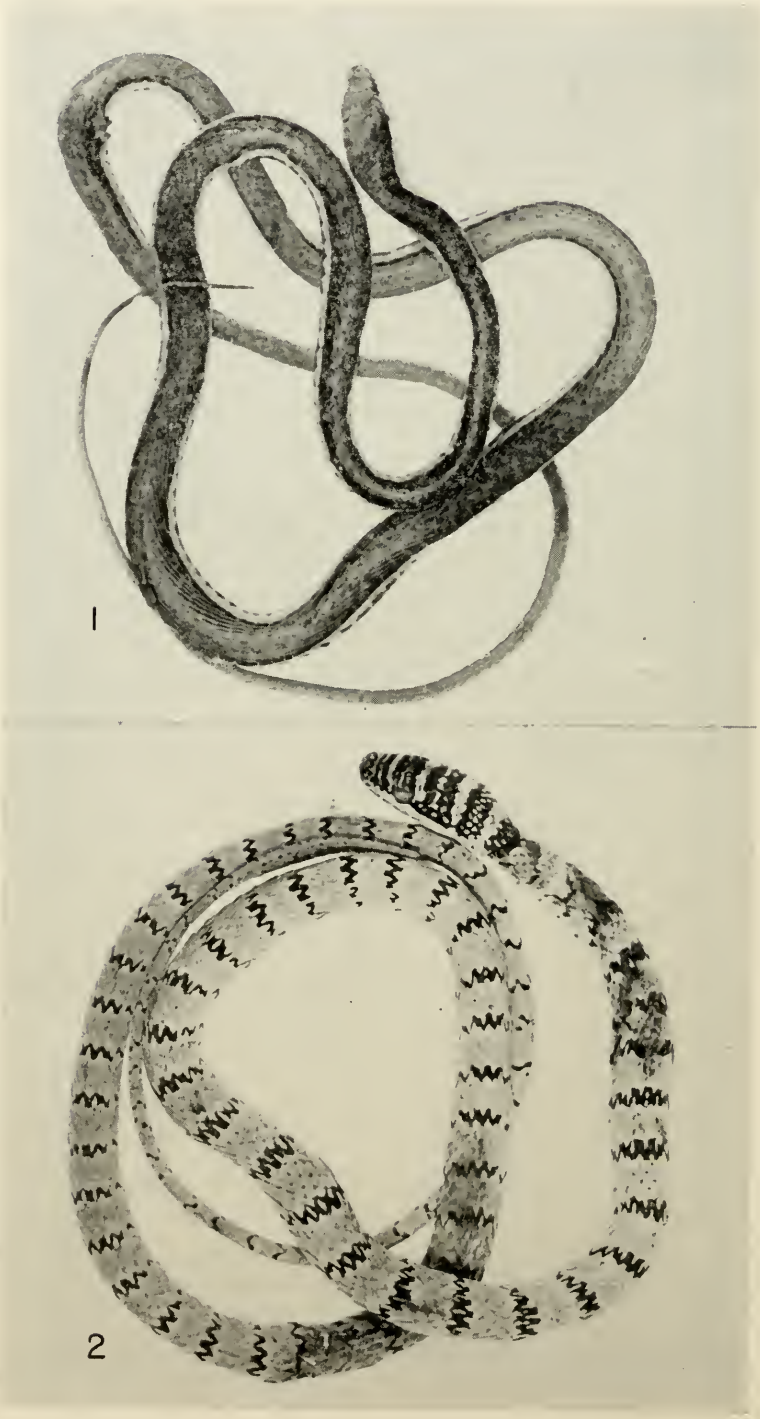
Type. EHT-HMS No. 30388 collected 12 miles north of Trincomalee, Ceylon, in 1944 by E. H. Taylor.

Diagnosis. Three labials, the fourth, fifth and sixth entering the eye; loreal absent; nasal divided at least partially; the posterior part largest and a little lower than anterior; temporals $1 + 1 + 3$; vertebral scales enlarged, smaller than scales of outer row; a lateral black headstripe continues through eye and to base of tail; a white line beginning on supralabials continues on the first and second scale rows, occupying most of first and lower half of second scale row; this bordered below by a black line beginning on neck and continuing to base of tail; tail gray without stripes.

Description of species. Rostral large, its width much greater than its height, part visible above slightly angular posteriorly; internasals longer than the prefrontals but much narrower; prefrontals bordering the second to fourth supralabials; frontal equally as long as its distance from the tip of snout; parietals as long as their distance from internasals; nasal elongate, completely or almost completely divided, the posterior portion lower and larger than the anterior which contains most of nostril; one large preocular, touching frontal; two postoculars, the upper much the larger; temporals $1 + 1 + 3$, the lower of the three almost below the second temporal; supralabials 9-9, the fourth to sixth bordering orbit; infralabials 10-10, five bordering first chinshields. Ventrals 173; anal divided; subcaudals divided, 134; ventrals keeled and notched on each side; subcaudals with rounded lateral ridges in lieu of lateral keels.

Color. Above bronzy gray to middle of third scale row, a cream white line bordered above and below by deep black passes on two outer scale rows to tail. Tail uniform bronzy gray. Belly cream white (in preservation the belly tends to become dark).

Measurements in mm. Total length, 756; tail, 250.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Remarks. The type specimen was taken in low forest near the beach. Its movements were moderately rapid. The species is dedicated to Dr. Jim Oliver who has contributed to the stabilization of the generic name of this form.

In 1909 * Werner described a Ceylon species lacking a loreal as *Dendrophis effrenis*. This species has been referred by most subsequent writers to the synonymy of *Ahaetulla candolineolata*. Even Werner does not recognize the form in his "Gattungen und Arten der Schlangen aus der Familie Colubridae" (Zool. Jahrb., Bd. 57, 1929).

This form belongs to the section of the genus having 15 scale rows and with three instead of two supralabials entering the eye. Werner's *effrenis* belonged to the group having 13 scale rows, with two labials entering the eye.

Ahaetulla tristis (Daudin)

Coluber tristis Daudin, Histoire Naturelle des Reptiles, vol. 6, p. 430 (Based on Russell, An Account of Indian Serpents, 1796, p. 36, pl. 31).

Chrysopelea boiei A. Smith, Mag. Zool. Bot., 1836, p. 144 (Ceylon).

Dendrophis helena Werner, Zool. Anz., 1892, vol. 16, p. 8 (Ceylon).

Dendrelaphis tristis var. *taprobanensis* Wall, Ophidia Taprobanica . . ., 1921, p. 221 (Ceylon).

There are seven specimens of this common species in the collections. These are EHT-HMS Nos. 30733-34; 30736-37; 30740-42, all from 12 miles north of Trincomalee.

A young specimen, U.S.N.M. 12494, differs in color characters from the others listed in having the anterior vertebral scales each with a cream spot. Each transverse, somewhat diagonal, row of scales has the posterior edge black thus forming as many narrow black lines as there are transverse scale rows; some of the scales have their lower edges dark also and together these form a series of dim diagonal transverse lines but directed obliquely backwards. This second series cannot be discerned on the second half of the body.

The two outer scale rows are largely cream but each third scale of the outer row either black-edged or with the adjacent scales black-edged so that there appears a series of black-edged yellowish cream spots. These are present only on the anterior half of body. Whether

* Mitt. Naturh. Mus. Hamburg, vol. 26, 1909, p. 221.

PLATE XVIII. Fig. 1. *Ahaetulla oliveri* sp. nov. EHT-HMS No. 30388 ♂ ; 12 miles north of Trincomalee, Eastern Province, Ceylon; total length, 756 mm. Fig. 2. *Chrysopelea taprobanica* Smith. EHT-HMS No. 31244 ♂ ; 12 miles north of Trincomalee, Eastern Province, Ceylon; total length, 656 mm.

this is the typical juvenile marking or whether this is an unusual condition, I cannot say.

The ventrals are 164, the subcaudals 125; the anal is divided.

Ahaetulla caudolineolata (Günther)

Dendrophis caudolineolatus Günther, Proc. Zool. Soc. London, 1869, p. 507, pl. 11, fig. 1 (type locality, Ceylon).

Dendrophis gregorii Haly, Taprobanian, 1888, vol. 3, p. 51 (Ceylon).

Dendrophis effrenis Werner, Mitt. Naturhist. Mus. Hamburg, vol. 26, 1909, p. 221 (Colombo, Ceylon).

No specimens of this species are in the collections. The species may be diagnosed by the following characters: scale rows 13-13-9; eight supralabials, the fourth and fifth bordering eye; anteriorly with diagonal dark lines; tail with four more or less distinct black longitudinal lines. Ventrals 149-164; subcaudals 119-128; anal divided.

GENUS CHRYSOPELEA Boie

Chrysopelea Boie, in Ferrusac, Bull. Sci. Nat., vol. 9, 1826, p. 237; and Isis, 1827, p. 520.

Two forms occur in Ceylon. They may be distinguished by the following key.

KEY TO CEYLON SPECIES OF CHRYSOPELEA

1. Scale preceding anal scale paired; greenish with transverse darker markings forming bands and with a median series of orange spots present ..... *ornata*
   Scale preceding anal scale single; light olive brown with about 62 black wavy or zigzag lines on body ..... *taprobanica*

Chrysopelea ornata (Shaw)

Coluber ornatus Shaw, General Zoology, 1802, vol. 3, p. 477 (based on Russell's Ind. Serp. 2, 1801, p. 4, pl. 2; unknown type locality, but presumably India).

Chrysopelea ornata Boie, Isis, 1827, p. 546.

No specimens from Ceylon have been examined. The flower-shaped spots of orange are said to be invariably present on Ceylonese specimens.

Chrysopelea taprobanica Smith

Pl. XVIII, fig. 2

Chrysopelea taprobanica Smith, Fauna of British India, Ceylon and Burma including the whole Indo-Chinese Subregion; Reptilia and Amphibia, vol. 3, Serpentes, Dec., 1943, p. 254 (type locality, Kanthali, Ceylon).

Crysopelea ornata (in part) of various authors.

This recently described species is represented in my collection by a single specimen (EHT-HMS No. 31244) collected 12 miles north of Trincomalee. It is surprising that the species was ever confused with *Chrysopelea ornata,* which likewise occurs on Ceylon, since the general appearance is quite different. The ground color of *taprobanica* is light olive brown with a series of 62 transverse wavy or

zigzag lines crossing the back that often break up low on the sides, and, at least in the posterior part of the body, they fail to reach to the ventrals. The greatest width of the black color is usually less than half a scale in width. These bands continue on the tail, but become indistinct towards the tip. Thirty or more can be counted. The ventrals are sharply keeled, notched laterally, and bear a broken row of black dots touching the keel. These dots are arranged in groups of three or two on contiguous scales, separated by a scale without a dot. They continue on the subcaudals but become irregular and are absent posteriorly.

When the outer epidermis is shed the color is light blue-gray. The head is black crossed by three continuous ivory-colored bands; between these are other bands made up of ivory flecks or spots and short lines. The chin and labials are ivory white.

The keels on the scales are indistinct and if the outer epidermis is shed can scarcely be discerned. The scale rows are 17-17-13. The anal is divided and the last ventral is single. The ventrals are 204; the subcaudals 110 + (the extreme tip missing).

The species is confined to Ceylon. It is known from the North Western Province (Kurunegala) and the northern part of Eastern Province (Kanthalai, and 12 mi. north of Trincomalee). It would appear to be a lowland form.

GENUS LYCODON Boie

Lycodon Boie, in Férrusac's Bull. Sci. Nat., vol. 9, 1826, p. 238 (part); Fitzinger, Neue Class. Rept., 1826, pp. 29, 30.

Genotype, *Lycodon aulicus*.

Only three species are known to occur in Ceylon.

KEY TO THE FORMS OF LYCODON IN CEYLON

1. Eight supralabials; ventrals not angulate laterally; ventrals (Ceylon) 154-166; subcaudals, 35-50; dark brown with whitish crossbars, which widen on sides, the expansions often enclosing triangular spots; or becoming pigmented; posteriorly bars narrower and closer together; below uniform white..... *striatus*

   Nine supralabials; ventrals angulate laterally; ventrals, 172-214; subcaudals, 57-80 2

2. Brown, lavender, or purplish, with white bands, which widen on the sides; labials cream without spots in their middle; diameter of eye two times in distance between eye and nostril; preocular touches frontal..... *aulicus aulicus*

   Brown or lavender with a series of small, whitish, dark bordered medial spots on anterior two thirds of body; eye diameter one and one half times in distance from eye to nostril; preocular separated from frontal..... *osmanhilli*

Lycodon aulicus aulicus (Linnaeus)

Pl. XIX, fig. 2

Coluber aulicus Linnaeus, Museum Adolphi Friderici regis, vol. 1, 1754, p. 29, pl. 12, fig. 2 (America); Systema Naturae, 10th ed., 1758, p. 222.

Lycodon aulicus Wall, Journ. Bombay Nat. Hist. Soc., vol. 15, 1904, p. 706; *idem.*, vol. 18, 1907, p. 112; *idem.*, vol. 19, 1909, p. 87, color pls. 344, 619; Smith, The Fauna of British India, Ceylon and Burma . . ., Reptilia and Amphibia, vol. 3, Serpentes, 1943, pp. 263-266, fig. 89.

Ophites aulicus Wall, Ophidia Taprobanica, or the Snakes of Ceylon, 1921, p. 151.

This species is represented by the following specimens: EHT-HMS Nos. 30708-30713, 12 mi. N. Trincomalee, Ceylon; U. S. N. M. No. 31247, "Ceylon."

The series of specimens from near Trincomalee are uniform in pattern and seemingly all are referrable to *L. a. aulicus*.

Temporal scales vary somewhat, the formula being $2+3+4$, or more frequently assuming a position of $\frac{1}{1+2}+4$ (3). The third, fourth and fifth supralabials border the orbit, five infralabials touch the anterior chinshields, which are somewhat larger than posterior. The scale formula is 19 (anteriorly on neck), 17, 17, 15.

The head is spatulate, flattened, the rostral only slightly visible above. The nasal is at least partially divided into two nearly equal parts and the loreal is in contact with the internasal.

The color on the dorsum and sides is lavender or purplish lavender (tending to turn brown after several years of preservation), crossed by 13 narrow, cream-white lines one and one half to three scales wide, that widen on the sides and become confluent with the lighter color of the venter. The top of the head is deep lavender bordered behind by a cream transverse band that is divided by a narrow tongue of lavender. The lips are cream except on the upper edges. Older specimens develop pigment on the scales of the white bands and the white may form only a reticulum; the borders of the lavender areas may be darkened and irregular.

Wall, *loc. cit.*, has called attention to the variation occurring in Indian and Ceylon specimens. It is surprising that the series here shows very little variation in color save that normally expected with age.

PLATE XIX. Fig. 1. *Sibynophis subpunctatus* (Duméril, Bibron and Duméril) EHT-HMS No. 31252 ♀; 12 miles north of Trincomalee, Eastern Province, Ceylon; total length, 355 mm. Fig. 2. *Lycodon aulicus aulicus* (Linnaeus). EHT-HMS No. 30712 ♀; 12 miles north of Trincomalee, Eastern Province, Ceylon; total length, 378 mm.

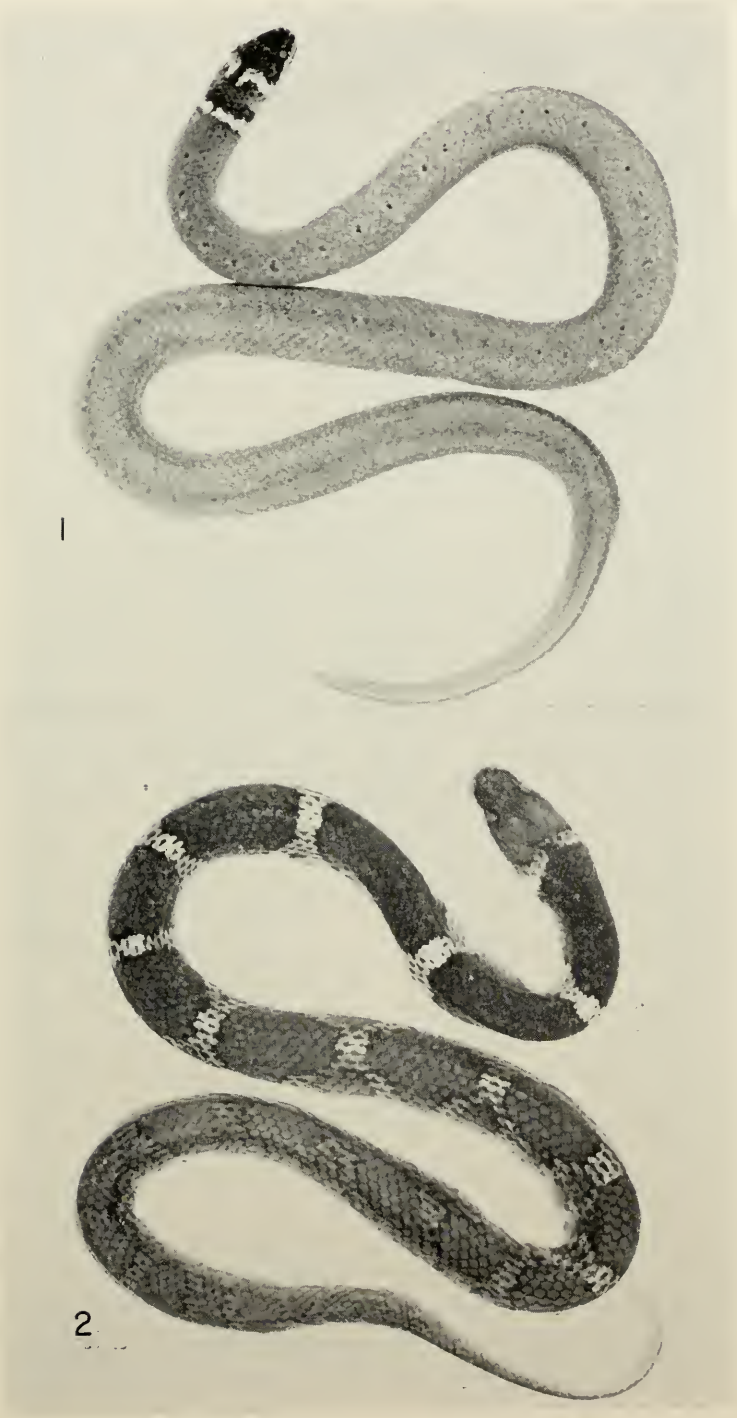
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TABLE OF DATA ON *Lycodon aulicus aulicus* (Linnaeus)

Number	Sex	Ventrals	Subcaudals	Supralabials	Infralabials	Oculars
30708	♂	185	67	9–9	11– 9	1, 2
30709	♂	184	65	9–9	11–11	1, 2
30710	♂	180	67	9–9	11–11	1, 2
30711	♀	201	63	9–9	10–11	1, 2
30712	♀	195	56	9–9	11–10	1, 2
30713	♂	181	67	9–9	11–10	1, 2
31247	♂	185	69	9–9	11–11	1, (2–3)

Lycodon striatus (Shaw)

Coluber striatus Shaw, General Zoology, vol. 3, 1802, p. 527 (Based on Russell's, An account of Indian Serpents . . ., pl. 16).

Lycodon striatus Smith, The Fauna of British India . . .. Reptilia and Amphibia, vol. 3, Serpentes, 1943, pp. 261-262, Ceylon (etc.).

No specimens of this species in the collection.

It may be distinguished by the presence of only eight supralabials, and in having the anterior part of nasal larger than posterior. The rounder rather than angulate condition of the ventral scales will separate this species from *Lycodon aulicus*. The ventrals are 185, subcaudals 69 + 1; the supralabials 9-9, the infralabials 11-11.

There is a single preocular but on the left side there are three postoculars instead of two, the usual number. The arrangement of the temporals is $\frac{1}{1+2}+4$. The third, fourth and fifth supralabials bound the orbit.

Lycodon osmanhilli sp. nov.

Pl. XX

Type. K. U. M. N. H. No. 24141, Colombo, Ceylon; W. C. Osman Hill, Coll., paratype U. S. N. M. No. 19215, "Ceylon."

Diagnosis. Diameter of eye (2.9 mm.) contained in distance between eye and nostril (4.0 mm.) 1.38 times; length of frontal equal to distance between frontal and rostral; tail (101 mm.) in total length (522 mm.) 5.38 times. Ventrals angulate; nine supralabials, each with a medial black spot; a series of small, dark-bordered cream spots on anterior two thirds of body; preocular separated from frontal.

Description of type. Rostral forming a sharp transverse ridge, its width twice as great as its height, the upper part bent at nearly a right angle, rather broadly visible from above; internasals a third longer than wide forming an angular suture with the rostral; prefrontals approximately one third longer than broad, their area more than three times that of the internasals; frontal shield-shaped

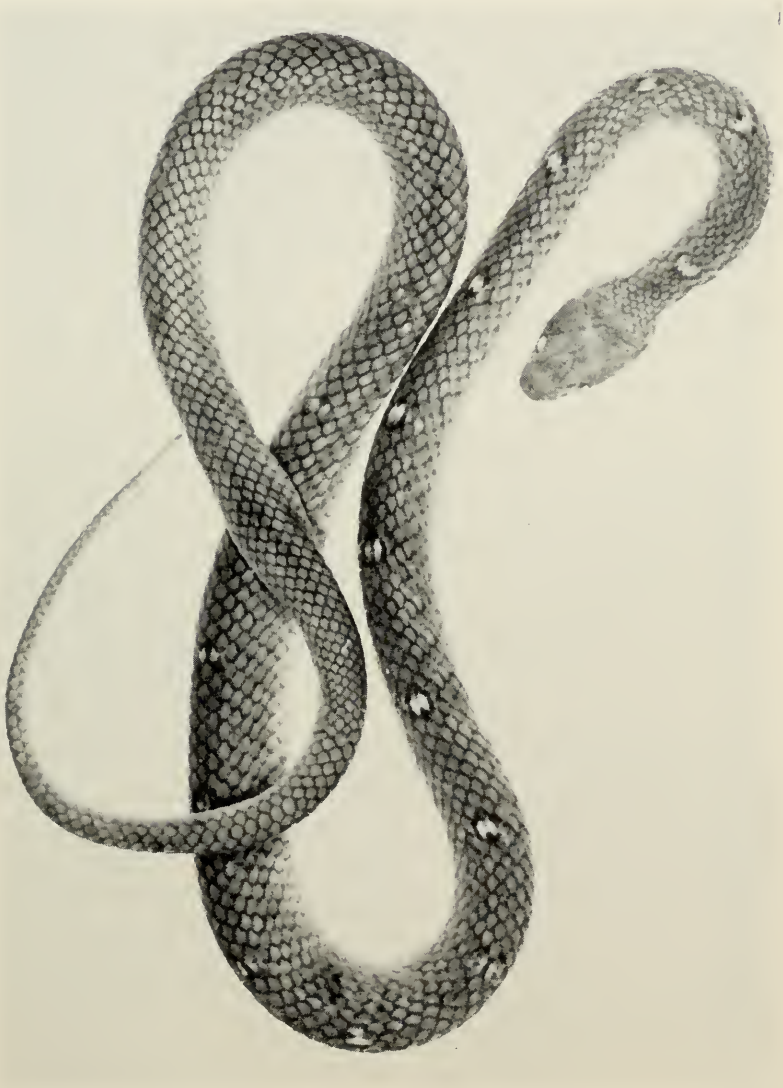


PLATE XX. *Lycodon osmanhilli* sp. nov. K.U.M.N.H. No. 24141; Colombo, Ceylon; total length, 522 mm.

nearly a third longer than wide, its length equal to its distance from rostral, and about one fourth shorter than a parietal; latter scales much narrowed posteriorly. Nasal divided, the nostril pointing upward and somewhat outward; anterior part of nasal largest; loreal elongate, more than twice as long as high; not in contact with the internasal; one preocular as high as wide, separated from frontal; two postoculars; temporals 2 + 3 + 4, those bordering the parietals not especially enlarged; supralabials 9-9, the third, fourth and fifth bordering the eye; infralabials 10-11, five bordering the first pair of chinshields, which are distinctly larger than second pair; neither the snout nor lower jaw constricted immediately in front of eye.

Across back of head 23 scale rows; on neck and body 17; in front of vent 15. Ventrals angulate, 187; anal divided; subcaudals 68. Scales smooth; single apical pits are discernible if the outer epidermis is not shed.

Color. The general color brown in alcohol, the top of head being uniform lavender brown, bordered along the upper edge of labials by a slightly darker line. All labials cream, with a darker upper edge and large dark medial spots; infralabials each with a dim darker spot; venter immaculate. Back brown with 19 cream spots covering part of three or four scales on middorsal line, each edged with dark brown; many lateral scales with very narrow white edges; latter third of body and tail lacking spots. Most of the dorsal and lateral scales are of a darker brown on their edges than in the middle.

Measurements in mm. Total length, 522; snout to vent, 421; tail, 101; greatest width of head, 10.6; greatest length of head (from jaw angle) 17.8.

Remarks. The paratype, U. S. N. M. No. 19215, is a young, perhaps somewhat faded specimen. However the general color pattern of the young is identical to that which obtains in the adult. There are 21 median white or cream spots, covering parts of four scales and completely or partially surrounded by dark brown. The dark labial spots are distinct.

The eye (as is usual in many snakes) is proportionately larger than in the adult and its diameter is only minutely less than distance between eye and nostril. The preocular is separated from the frontal, and other head scales have the general shape and proportions as those of the type.

The following scale characters are present: supralabials, 9-9; infralabials 11-11, five touching the first chinshields; one loreal; one

preocular; 2-3 postoculars; scale formula, 19-17-17-15. Ventrals, 186; subcaudals (divided) 70 (the terminal subcaudal scale equal to the length of the preceding five pairs of subcaudals); anal divided.

Comparisons. The species here treated as *Lycodon aulicus aulicus* although having a somewhat similar scale formula differs in pattern, in the size of eye, which is smaller, in the constriction of the snout in front of or at eye. The eye is contained in the nostril to eye distance more than twice, the eye being smaller and the distance greater than in *osmanhilli*. When two specimens of near equal length are compared, *Lycodon aulicus aulicus* is more robust, with a broader and a longer head. The supralabials and infralabials lack the median dark spots.

Two specimens of *aulicus*, one a little longer and one a little shorter, are compared by a series of measurements.

COMPARATIVE MEASUREMENTS OF *Lycodon osmanhilli* AND *L. aulicus aulicus*

Number	Total length	Tail	Head length	Head width greatest	Eye diameter	Eye to snout tip	Eye to nostril	Tail in total length
30710	545	98	21.1	13.2	2.9	7.1	5.45	5.56
24141	522	99	17.8	10.6	2.9	5.8	4	5.38
30713	498	95	19.2	11.3	2.2	6.3	4.5	5.24

Nos. 30710, 30713—*L. aulicus aulicus* from 12 mi. N. Trincomalee.
No. 24141—Type of *osmanhilli*.

In *Lycodon aulicus aulicus* the preocular is much higher than long and is in contact with the frontal. The temporals bordering the parietals are enlarged, there being only three on each side (four in *osmanhilli*). The loreal is deeper, its width minutely less than twice in length. The length of the frontal equals distance from the frontal to the middle of the internasals. There is no significant difference between the counts of the ventrals and subcaudals in the two forms. The counts of the ventrals in males are 181-185 (186-187); subcaudals 65-69 (68-70); in the females, 195-201; subcaudals 56-63 (counts for *osmanhilli* in parenthesis).

The species is named for Dr. W. C. Osman-Hill of Edinburgh, Scotland, who has collected widely in Ceylon.

GENUS CERCASPIS Wagler

Cercaspis Wagler, Natürliches System der Amphibien, 1830, p. 91.
Genotype, *Hurria carinata* Kuhl.

Cercaspis carinatus (Kuhl)

Hurria carinata Kuhl, Beitr. Zool. Vergl. Anat., 1820, p. 93 (type locality unknown).

Cercaspis carinatus Günther, Reptiles of British India, 1864, p. 324; Wall, Spolia Zeylanica, vol. 9, 1921, pp. 399, 404; and vol. 13, 1924, p. 77; Ophidia Taprobanica, or the Snakes of Ceylon, 1921, pp. 162-165; Journ. Bombay Nat. Hist. Soc., vol. 29, 1923, p. 614; Smith,

Fauna of British India . . ., Reptilia and Amphibia, vol. 3, Serpentes, 1943, p. 268-269, fig. 90 (vertebrae).

Lycodon carinatus Boulenger, Fauna British India, 1890, p. 297; and Catalogue of the Snakes in the British Museum, vol. 1, 1893, p.358.

This species resembles closely in external characters certain species of *Lycodon* but differs in an extraordinary manner in having the very greatly broadened prezygapophyses on the vertebrae. Smith (*loc. cit.*, footnote p. 267) states that this same condition is present "also in S. American *Xenopholis*."

No specimen in the collection.

GENUS DRYOCALAMUS Günther

Dryocalamus Günther, Catalogue of the Colubrine Snakes in the Collection of the British Museum, 1858, p. 121.

Genotype, *Dryocalamus tristrigatus*.

Two species occur in Ceylon, neither of which is endemic.

KEY TO THE CEYLON FORMS OF DRYOCALAMUS

Scales in 13 rows; one or two preoculars; nasal undivided or partially divided.... *nympha*
Scales in 15 rows; one preocular; nasal divided more or less completely..... *gracilis*

Dryocalamus nympha (Daudin)

Coluber nympha Daudin, Histoire Naturelle des Reptiles, 1803, vol. 6, p. 244, pl. 75.

Dryocalamus nympha Boulenger, Catalogue of the Snakes in the British Museum, vol. 1, 1893, p. 370.

No specimens in the collections.

These smooth-scaled snakes reach a length of about half a meter. The nasal is not or only partially divided below the nostril. The scale formula is 13-13-13. The head is flattened and distinctly wider than the body. Ventrals 200-236; subcaudals 65-88.

Dryocalamus gracilis (Günther)

Adontomus gracilis Günther, The Reptiles of British India, 1864, p. 234 (type locality, Anamally Hills).

Dryocalamus gracilis Boulenger, Catalogue of the Snakes in the British Museum, vol. 1, 1893, p. 371.

No specimens in the collection.

In this species the nasal shield is more or less completely divided. The loreal is in broad contact with the orbit and has usually a small preocular above it bordering orbit. The scale formula is 15-15-15. Ventrals 199-243; subcaudals, 75-87.

GENUS NATRIX Laurenti

Natrix Laurenti, Specimen Medicum, exhibens Synopsin Reptilium emendatum, 1768, p. 73.

Genotype, *Natrix vulgaris* = *Coluber natrix* Linnaeus.

Three forms are known to occur in Ceylon. These may be differentiated by the following key.

KEY TO CEYLON SPECIES OF NATRIX

1. Posterior maxillary teeth enlarging gradually; no dorsolateral buff stripes; two diagonal lines below and behind eye 2
The last two or three posterior maxillary teeth abruptly enlarged; usually buff dorsolateral stripes present, more distinct posteriorly; no diagonal lines below and behind eye ..... *stolata*
2. Anterior half of body pale olive or reddish, with two series of more or less distinct alternating large roundish or rhomboidal, dark olive or brown, black-edged spots, which are partly confluent on the vertebral line (sometimes forming a sinuous band); posterior part of body of uniform color or with longitudinal rows of dark spots; 2 diagonal lines below and behind eye; ventrals, 131-146; subcaudals, 83-90 ..... *asperrimus*
Anterior half of body with a dim black-edged nuchal band, followed by a median darker spot with a lighter center; behind this six series of irregular darker spots arranged in longitudinal lines, the individual spots often dim and often confluent; series of narrow vertical light spots sometimes confluent on the median line. Ventrals, 131-140; subcaudals, 78-90 ..... *piscator piscator*

Natrix asperrimus (Boulenger)

Pl. XXI, fig. 1

Tropidonotus asperrimus Boulenger, Ann. Mag. Nat. Hist., ser. 6, vol. 7, 1891, p. 281; and Catalogue of the Snakes in the British Museum, vol. 1, 1893, p. 232, pl. 15, fig. 2 (type locality, Ceylon).

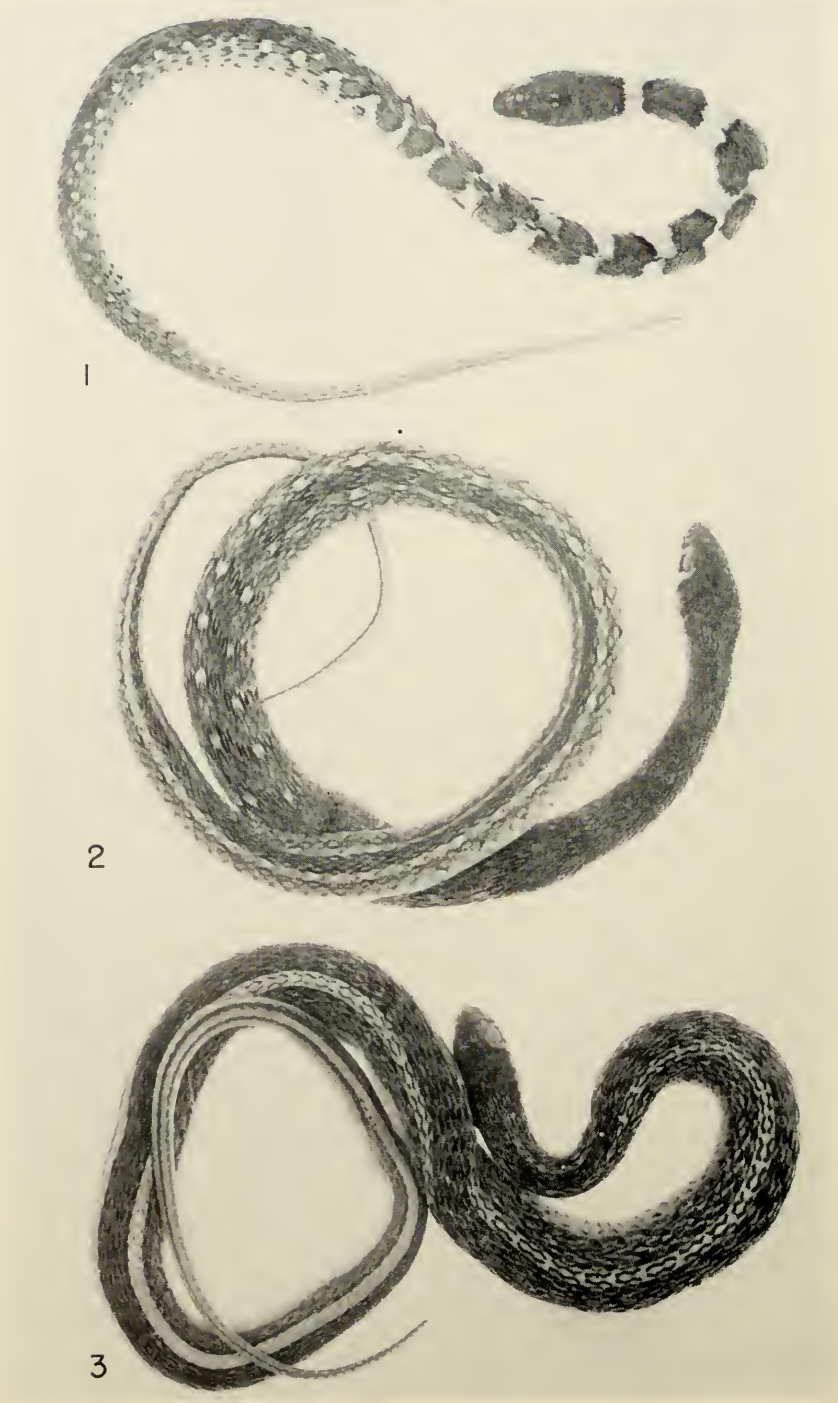
Natrix piscator asperrimus Smith, The Fauna of British India . . ., Reptilia and Amphibia, vol. 3, Serpentes, 1943, p. 296.

Two specimens (U. S. N. M. Nos. 120329-30) are present in the collections. The form may be recognized by the characters presented in the Key.

Unless it can be shown that in Ceylon *piscator* and *asperrimus* have ranges distinct from each other and show intergradation, I regard it as necessary to consider them distinct species, as proposed by Boulenger.

The head of No. 120329 is dark blackish brown to black, the color continuing about nine scale lengths behind the parietals; the whitish nuchal band is three scales wide on the middorsal line, then widens on the sides and becomes confluent with the ventral coloration. A pair of diagonal lines are under eye, enclosing a white area, the upper being continued as a border on the dark spot of the head, the other is traceable across the jaw. A series of dashlike black marks are present on the edges of the ventrals and the first scale row. The series of dorsal spots are separated by transverse light bars for nearly half the length of the body. Posteriorly the large spots gradually disappear, and a few narrow indistinct dark markings can be discerned together with a series of very small white spots present on each side to the tail. The subcaudals are bordered by a black line. Ventrals 133; subcaudals 72.

No. 120330 has become nearly unicolor but some trace of the markings are visible when submerged in water.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Natrix piscator (Schneider)

Pl. XV, fig. 2

Hydrus piscator Schneider, Historia Amphibiorum naturalis et literaria, vol. 1, 1799, p. 247 (Based on Russell's, An Account of Indian Serpents, pl. 33).

Natrix piscator piscator Smith, Rec. Indian Mus., vol. 42, 1940, p. 483; and The Fauna of British India . . ., Reptilia and Amphibia, vol. 3, Serpentes, 1944, p. 295.

Smith, in his recent Fauna of British India, does not consider this species or subspecies as occurring in Ceylon. A series of specimens, Nos. 20724-20728, 30730, which I collected 12 miles north of Trincomalee, are referred to *Natrix piscator* and seemingly are more closely related to the typical form than to any other as regards the pattern. One specimen, No. 30729, was collected between Anuradapura and Colombo, about 50 mi. S of the former city.

TABLE OF DATA ON *Natrix piscator*

Number	Sex	Ventrals	Subcaudals	Supralabials	Infralabials	Preocular	Postoculars
30724	♀	139	85	9–9	10–10	1–1	3–3
30725	♀	139	53 +	9–10	11–10	1–1	3–3
30726	yg.	131	47 +	9–9	10–10	1–1	3–3
30727	♀	138	87	9–9	11–10	1–1	3–3
30728	♀	140	83	9–9	10–10	1–1	3–3
30729	♂	134	90	9–9	11–10	1–1	3–3
30730	♀	136	78	9–10	10–10	1–1	3–3

The pattern of dorsal spots is distinct in certain specimens, less so in others. In all, the spots are more or less contiguous, and not of solid color. The black usually outlines three or four scales whose centers are much lighter. The small narrow vertical white spots (never as wide as one scale length) are present on the sides of all the specimens, usually as far as the base of the tail. They can be discerned even when the pattern of dark spots is indistinct. In one specimen the white spots tend to meet on the middorsal line, and they are least conspicuous in the specimen from the western side of the island south of Anuradapura.

PLATE XXI. Fig. 1. *Natrix asperrimus* (Boulenger). U.S.N.M. No. 120329; Nandana Estate, Kandy District, Central Province, Ceylon; total length, 252 mm. Fig. 2. *Natrix stolata stolata?* EHT-HMS No. 30706 ♀; 12 miles north of Trincomalee, Eastern Province, Ceylon; total length, 415 mm. (tail light below). Fig. 3. *Natrix stolata stolata* (Linnaeus). EHT-HMS No. 30705; Kandy, Central Province, Ceylon; total length, 440 mm.

Natrix stolata stolata (Linnaeus)

Pl. XXI, figs. 2 and 3

Coluber stolatus Linnaeus, Systema Naturae, 10th ed., 1758, p. 219 (type locality, Asia).
Natrix stolata Smith, The Fauna of British India . . ., Reptilia and Amphibia, vol. 3, Serpentes, 1943, pp. 303-305.

Three specimens in the EHT-HMS collection from Ceylon: No. 30705 from Kandy; Nos. 30706-07 from 12 mi. N of Trincomalee.

The specimen from Kandy, Ceylon, is gray (brownish gray before loss of the epidermis), the edges of some of the scales and the intervening skin between some of the scales whitish. Near the head a lighter line begins on each side covering approximately half of the fifth and seventh scale rows and all of the sixth row on the anterior two thirds of the body. Posteriorly the stripe is on the fourth, fifth and sixth rows to the vent. The stripe continues to the tip of the tail. Anteriorly the scales of the stripe are dark edged and a chain-like pattern is in evidence on the white stripe; posteriorly the dark markings are lacking on the stripe. A black dot is present on the outer edge of the ventrals on the anterior half of the body. Between the stripes there is a series of transverse dark markings having irregular edges (these are continued below the dorsolateral line). The ventrals are ♂ 143, the subcaudals 77 with possibly a few more missing from the tip.

The specimens from Trincomalee differ from the specimen described in having the dorsolateral light line indistinct throughout the anterior part of body but beginning one or two headlengths behind the head is a series of buff spots slightly darker edged which continue back two thirds the length of the body. Posteriorly the stripe is more distinct but considerable pigment is scattered on the scales of the stripe and the lateral spots are more or less indicated. Darker markings between the stripes can be discerned with difficulty. A second row of lighter spots can be discerned on the outer scale row. These also are bordered with darker color. The dark marks on outer edge of the ventrals appear on only a few scales. The markings on the sides of the head consist of a vertical light line in front of and behind eye. The labials are cream with dark linear spots on the first six that tend to border the sutures.

The scales of Nos. 30706 and 30707 are respectively: ventrals, 125, 126; subcaudals, 66, 69.

The specimens are insufficient in number to determine whether these differences of color are constant and whether there is as large a constant difference in the ventrals and subcaudals as is here indicated (maximum 25 ventrals and subcaudals). Usually females have

a larger number of ventrals and the count of males of the lowland form will probably be even less than the low figures here given for the females.

GENUS BALANOPHIS Smith

Balanophis Smith, Proc. Zool. Soc. London, 1938, p. 583.
Genotype, *Tropidonotus ceylonensis* Günther.

One species known, endemic in Ceylon.

Balanophis ceylonensis (Günther)

Tropidonotus chrysargus ceylonensis Günther, Catalogue of the Colubrine Snakes in the Collection of the British Museum, 1858, p. 71 (type locality, Ceylon).

Balanophis ceylonensis Smith, Proc. Zool. Soc. London, 1938, p. 538; and The Fauna of British India . . ., Reptilia and Amphibia, vol. 3, Serpentes, 1943, pp. 310-311, fig. 98, A and B.

This rare snake has a series of 24-26 maxillary teeth followed by two enlarged grooved fangs. It may be diagnosed by the following characters. Scales in 19 rows, all except outer row with keels; two preoculars, three postoculars; eight supralabials, four infralabials touching first pair of chinshields; ventrals, 131-141; subcaudals, 40-54; anal divided. Olive brown above, with more or less distinct reticulated, black cross bars, enclosing a dorsolateral series of large yellow or reddish black-edged spots. A dark brown stripe from behind eye on neck; skin between scales scarlet, the color evident when the snake inflates its body.

GENUS MACROPISTHODON Boulenger

Macropisthodon Boulenger, Catalogue of the Snakes of the British Museum (Natural History), vol. 1, 1893, p. 265.
Genotype, *flaviceps*.

Only one of the four species of the genus is found in Ceylon. It is also distributed widely in India.

Macropisthodon plumbicolor (Cantor)

Pl. XIII, fig. 2

Tropidonotus plumbicolor Cantor, Proc. Zool. Soc. London, 1839, p. 54 (type locality, Malwa [Saugor], Central India).

Macropisthodon plumbicolor Boulenger, Catalogue of the Snakes in the British Museum (Natural History), vol. 1, 1893, pp. 267-268; Smith, Fauna of British India, Ceylon and Burma, including the whole Indo-Chinese subregion; Reptilia and Amphibia, vol. 3, Serpentes, pp. 314-316, fig. 99, A and B.

I obtained a single specimen in second growth forest 12 miles north of Trincomalee (EHT-HMS No. 30681). The scale formula is 27, (head), 23, 23, 17. There are 151 ventrals and 34 subcaudals, and the anal is divided. There is only a single preocular, the loreal entering the eye. There are three postoculars present and the temporals

are 2 + 3. The fangs of this form are very greatly enlarged and are directed backwards in the mouth.

The color in life was nearly uniform dull green above with some suggestion of darker bands on the anterior part of the body. On distending the skin these are well defined. Light pinkish areas are discernible on the sides on the anterior half of the body. The two outer scale rows are lighter than the others. The belly is uniform light cream with a minute dusting of darker pigment on the outer part of the ventrals. The specimen is a female.

The range of ventrals and caudals for Ceylon specimens given by Smith (*loc. cit.*) is: ventrals, 153-154; subcaudals ♂ 40-45; ♀ 37-47 based on 5 Ceylon specimens. The young are strongly marked with a V-shaped spot on the neck, followed by an area of bright orange. Numerous black bars run across the body and tail. The species is rare in the plains regions, but is encountered frequently in the mountains. Its range extends to an elevation of 7,000 feet.

GENUS ATRETIUM Cope

Atretium Cope, Proc. Acad. Nat. Sci. Philadelphia, 1861, p. 299.
Genotype, *schistosum*.

Atretium schistosum (Daudin)

Coluber schistosus Daudin, Histoire Naturelle des Reptiles, vol. 7, 1803, p. 132 (Based on Russell's An Account of Indian Serpentes, vol. 2 pl. 4).
Atretium schistosus Günther, Reptiles of British India, 1864, p. 273.

This species may be recognized easily by the fused internasals, valvular nostrils directed more or less upward, scales keeled without apical pits, one preocular, two or three postoculars, eight or nine supralabials, the scale formula 19-19-17 all more or less distinctly keeled, strongly so on posterior part of body. Ventrals 129-160; subcaudals 53-85. Anal divided.

No specimens in the collection.

GENUS ASPIDURA Wagler

Aspidura Wagler, Natürliches System der Amphibien, 1830, pp. 132, 191.
(Genotype, *brachyorros* Boie.)

This genus has long been regarded as confined to Ceylon. However, Laidlaw* reports the species in the Maldive Archipelago. It is not impossible, if the data are correct, that the species has been introduced from Ceylon, since it is the snake species most common in that island and in places it is reported as "exceedingly common."

* Laidlow, in Gardiners, The Fauna and Geography of the Maldive and Laccadive Archipelagoes, vol. 1, pt. 2, 1902, Amphibia and Reptilia, pp. 119-122.

KEY TO THE SPECIES OF ASPIDURA

1. Scales in 15 rows; a preocular present ..... *trachyprocta*
   Scales in 17 rows 2
2. Two postoculars touching the parietal 3
   Upper postocular touching the parietal; a preocular; snout pointed; subcaudals single ..... *guentheri*
3. A preocular present; supraocular more than half length of frontal; snout rounded, *brachyorrhus*
   No preocular 4
4. Supraocular not half length of frontal; snout rounded; subcaudals undivided (usually) ..... *copii*
   Supraoculars more than half length of frontal; snout pointed; subcaudals paired, *drummondhayi*

Aspidura drummondhayi Boulenger

Aspidura drummond-hayi Boulenger, Spolia Zeylanica, vol. 2, 1904, p. 95, pl. —— (type locality, Balangoda district, Ceylon); Wall, Ophidia Taprobanica or the Snakes of Ceylon, 1921, pp. 213-214; Journ. Bombay Nat. Hist. Soc., vol. 29, 1923, p. 611; Smith, The Fauna of British India, Ceylon and Burma including the Whole of the Indo-Chinese subregion; Reptilia and Amphibia, vol. 3, Serpentes, Dec., 1943, p. 338.

No specimens examined.

Aspidura trachyprocta Cope

Pl. XVII, fig. 2

Aspidura trachyprocta Cope, Proc. Acad. Nat. Sci. Philadelphia, 1860, pp. 75-76 (type locality, Ceylon); Günther, Reptiles of British India, 1864, p. 203, pl. 18, figs. F, F'; Boulenger, Fauna of British India including Ceylon and Burma, Reptilia and Batrachia, 1890, p. 290; and Catalogue of the Snakes of the British Museum (Natural History), vol. 1, 1893, p. 313; Fletcher, Spolia Zeylanica, vol. 5, 1908, p. 98; Wall, Ophidia Taprobanica or the Snakes of Ceylon, Colombo, 1921, pp. 209-213; Smith, Fauna of British India, Ceylon and Burma, including the whole Indo-Chinese subregion; Reptilia and Amphibia, vol. 3, Serpentes, p. 337, fig. 106.

Five specimens, U. S. Nat. Mus. Nos. 19214 Juv. and 56150 ♀ "Ceylon"; EHT-HMS Nos. 31245 ♂ and 31246 ♀ "Ceylon"; and K. U. M. N. H. No. 24139 ♂ Nuwara Eliya, Ceylon, are at hand, all falling within the limits of variation of the species.

The type specimen according to Cope's description has two unusual characters: a central plate separating the second chinshields, and a small central postanal plate. These characters at least are lacking in the specimens at hand. The characters of the scales on the sides of the anal plate, and the postanal plates do vary however. In one, No. 31245, there is a small pair of scales inserted between the outer part of the anal plate and the ventral scale preceding; on each side of the anus, and partly concealed by the anal plate are four scales, increasing in size posteriorly. However the pairs fail to meet. The first postanal is large and single. Towards the end of the tail there are two divided subcaudals. In the female, No. 31246, the four scales border the side of the vent, but the last pair is in contact; the intercalated scale between the anal and the preceding ventral is present on one side only. In No. 56150 there are no intercalated scales, and but three scales border the vent, the last

pair not in contact behind the anus. The first two subcaudals are divided. The females lack the clawlike keels or tubercles on the lateral scales preceding and following the vent.

The ventral and subcaudal counts for Nos. 19214 Juv., 31245 ♂, 31246 ♀, and 56150 ♀, respectively, are: 142-23; 141-20; 135-13; 143-16.

These small snakes may be easily recognized by the sharp snout, with a single internasal. The rostral is very small and is visible above only as a point. The nostril is pierced between two nasals and the first labial. The scale formula is 15-15-15.

No. 31246 ♂ has a single median discontinuous line and a median ventral irregular series of dark brown spots.

Nos. 56156 ♂ and 31245 ♂ have two or three or more irregular series of small blackish dorsal spots. A brownish line passes back from eye on to the neck. The venter of the second specimen has considerable pigment scattered across each scale and not forming discrete spots.

No. 24139 is dark, nearly uniform bluish black with a row of eight spots on the third scale row; the belly is light (red or yellow in life ?) with very numerous quadrangular black spots varying in size.

Whether the black specimen is racially distinct from the remainder listed, I do not know. The cephalic scale pattern is faithfully duplicated in all. The rostral from Nuwara Eliya is truncate above while in the others it is pointed and touching the fused internasal at a single point. Unfortunately the provenance of the other specimens are unknown.

Aspidura brachyorrhus (Boie)

Scytale brachyorrhos Boie, Isis von Oken, 1827, p. 517.

Aspidura brachyorrhos Boulenger, Fauna British India including Ceylon and Burma, Reptilia and Batrachia, London, 1890, p. 288; Catalogue of the Snakes in the British Museum (Natural History), vol. 1, 1893, p. 311; Wall, Ophidia Taprobanica or the Snakes of Ceylon, 1921, pp. 204-207, fig. 43; and Journ. Bombay Nat. Hist. Soc., vol. 29, 1923, p. 611.

Calamaria scytale Schlegel, Essai sur la Physionomie des Serpens, vol. 2, 1837, p. 42 (based on Boie's *Scytale brachyorrhos*).

No specimens examined.

Aspidura guentheri Ferguson

Aspidura guentheri Ferguson, Proc. Zool. Soc. London, 1876, p. 819 (type locality, Coast of the West Province, Ceylon); Boulenger, Fauna British India, including Ceylon and Burma Reptilia and Batrachia, 1890, p. 290; and Catalogue of the Snakes in the British Museum, vol. 1, 1893, p. 312, pl. 20, fig. 3; Wall, Ophidia Taprobanica or the Snakes of Ceylon, 1921, p. 208-209; and Journ. Bombay Nat. Hist. Soc., vol. 29, 1923, p. 611; Smith, Fauna British India, Ceylon and Burma including the whole of the Indo-Chinese subregion; Reptilia and Amphibia, vol. 3, Serpentes, Dec., 1943, p. 338.

No specimens at hand.

Aspidura copii Günther

Aspidura copii Günther, Reptiles of British India, 1864, p. 203, pl. 18, fig. E (type locality ,Ceylon); Boulenger, Fauna British India including Ceylon and Burma, Reptilia and Batrachia, 1890, p. 289; and Catalogue of the Snakes of the British Museum (Natural History), vol. 1, 1893, pp. 311-312; Wall, Ophidia Taprobanica or the Snakes of Ceylon, 1921, pp. 207-208; and Journ. Bombay Nat. Hist. Soc., 29, 1923, p. 611; Smith, Fauna British India . . ., Reptilia and Amphibia, vol. 3, Serpentes, 1943, pp. 336-337.

No specimens at hand.

GENUS HAPLOCERCUS Günther

Haplocercus Günther, Catalogue of the Colubrine Snakes in the Collection of the British Museum, 1858, p. 290.

Genotype, *ceylonensis*.

A single recognized form is endemic in Ceylon. It is said to be common in certain highland districts.

Haplocercus ceylonensis Günther

Haplocercus ceylonensis Günther, Catalogue of the Colubrine Snakes in the Collection of the British Museum, 1858, p. 14 (type locality, Ceylon); and Reptiles of British India, 1864, p. 204, pl. XVIII, fig. G; Boulenger, Fauna of British India including Ceylon and Burma; Reptilia and Batrachia, 1890, p. 291; and Catalogue of the Snakes in the British Museum (Natural History), vol. 1, 1893, pp. 309-310; Wall, Journ. Bombay Nat. Hist. Soc., vol. 29, 1923, p. 610, and Ophidia Taprobanica or the Snakes of Ceylon, 1921, p. 143-146, fig. 33; Smith, Fauna of British India, Ceylon and Burma including the whole of the Indo-Chinese subregion; Reptilia and Amphibia, vol. 3, Serpentes, Dec., 1943, pp. 340-341, fig. 109.

Aspidura carinata Jan, Arch. Zoöl., 1862, 2, p. 30; and Elenco Sistematico Degli Ofidi, 1863, p. 35; and Iconographie Générale des Ophidiens, livr. 13, 1865, pl. I, fig. 5 (type locality, Ceylon).

Aspidura ceylonensis Theobald, Descriptive Catalogue of the Reptiles of British India, 1876, p. 143.

A single Ceylonese specimen, U. S. Nat. Mus. No. 5896 lacks exact locality data. In color and pattern it agrees with Günther's excellent figure (*loc. cit.*), and falls within the known limits of variation of the species. The ventrals are 204, the anal single, the subcaudals 44.

The relationship of this genus is apparently with *Aspidura*. However much the resemblance with that genus, the differences are such as to warrant the separation into a separate genus. The variation in the ventral count is high—277 to 307; while the variation in the subcaudals is 37-56. The females have a ventral range 192-207; subcaudals, 37-50; males, ventrals 177-180; subcaudals 42-56. The greatest variation in number of scales is between a male* with a ventral-subcaudal count of 219 scales and a female with 257, representing a total difference of 38. It is possible that so large a difference is indicative of racial differentiation.

* Boulenger Catalogue, *loc. cit.*, p. 310.

GENUS BOIGA Fitzinger

Boiga Fitzinger, Neue Class. Rept., 1826, pp. 29, 30, 60.
Genotype, *Coluber irregularis* Merrem.

Five forms of the genus are known to occur in Ceylon.

KEY TO THE CEYLONESE SPECIES OF BOIGA

1. Three preoculars; scale rows 19 at midbody reducing to 15 near vent; 4th and 5th labials enter orbit; length, 2 feet (?)..... *barnesi*
   One preocular; scales 19-27 at midbody; 3d, 4th and 5th labials enter orbits.... 2
2. Scales in 19-21 rows; head color variable..... 3
   Scales in 25-27 rows at midbody; a medial and two lateral stripes on the head; length, 7 ft. ..... *forsteni*
3. Scales in 21 rows reducing to 15 posteriorly; vertebrals enlarged but slightly, *trigonatus*
   Scales in 19 rows reducing to 15 (13) posteriorly; vertebrals large, nearly as broad as long 4
4. Head powdered brown without spots; total ventrals and subcaudals, 362-390; length, 3.5-4 ft..... *beddomei*
   Head with dark markings; total ventrals and subcaudals, 311-342; length about 4 ft. ..... *ceylonensis*

Boiga barnesi (Günther)

Dipsas barnesi Günther, Proc. Zool. Soc. London, 1869, p. 506, pl. xl, fig. 2 (type locality, Ceylon).

Boiga barnesi Smith, Fauna of British India, Ceylon and Burma . . .; Reptilia and Amphibia, vol. 3, Serpentes, 1943, pp. 354-355.

A rare species in Ceylon. Smith states that it is known only from two specimens. Ventrals 208-220; caudals, 98-100.

Boiga trigonata (Schneider)

Coluber trigonatus Schneider, in Bechstein, transl. Lacépède, vol. 4, 1802, p. 356, pl. xl, fig. 1 (type locality, Vizagapatam, India).

Boiga trigonata Nikolski, Faune de la Russie, 1916, p. 187, pl. VI (*trigonatum*); Smith, Fauna of British India . . .; Reptilia and Amphibia, vol. 3, Serpentes, 1943, pp. 349, 350, figs. 111, a-d.

Known only from Uva province in Ceylon.

Boiga beddomei (Wall)

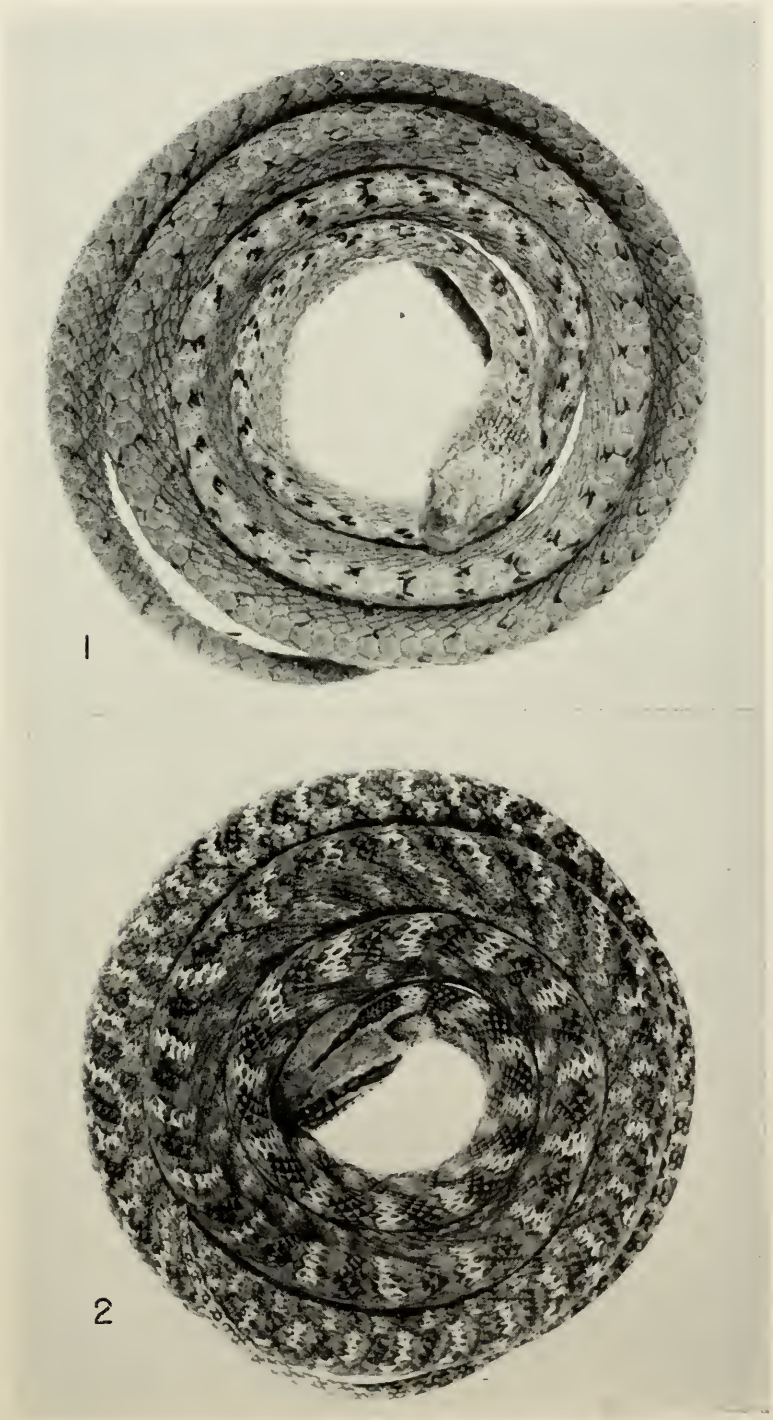
Pl. XXII, fig. 1

Dipsadomorphus beddomei Wall, Records of the Indian Museum, 1909, p. 152; and Ophidia Taprobanica or the Snakes of Ceylon, 1921, pp. 282-283 (type locality, Ceylon).

Boiga ceylonensis Smith, The Fauna of British India, Ceylon and Burma . . .; Reptilia and Amphibia, vol. 3, Serpentes, 1943, pp. 351-353.

Two specimens (EHT-HMS Nos. 30674-75) were captured 12 miles north of Trincomalee, Ceylon. The first was collected from under the bark on a standing, dead tree at an elevation of eight feet

PLATE XXII. Fig. 1. *Boiga beddomei* Wall. EHT-HMS No. 30675 ♂; 12 miles north of Trincomalee, Eastern Province, Ceylon; total length, 1,190 mm. Fig. 2. *Boiga forsteni* Duméril, Bibron and Duméril. EHT-HMS No. 30676 ♂; 12 miles north of Trincomalee, Eastern Province, Ceylon; total length, 1,130 mm.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2

from the ground. The second was obtained at night crawling along the foundation of a building.

The specimens seem to be placed properly in this species. The young specimen, No. 30674, was pinkish-fawn in life with diagonal grayish markings on the sides. On the median dorsal surface are small deep black spots tending to become paired, although occasionally they are distinctly alternating. A dim dark line is present from the eye to the mouth angle. The belly is light, peppered sparsely with grayish, occasionally tending to form spots on the outer ventrals, in the latter half of body.

Boiga ceylonensis (Günther)

Dipsadomorphus ceylonensis Günther. Catalogue of the Colubrine Snakes in the Collection of the British Museum, 1858, p. 176 (type locality, Ceylon).

Boiga ceylonensis Smith, Fauna of British India, Ceylon and Burma . . .; Reptilia and Amphibia, vol. 3, Serpentes, 1943, pp. 351-353.

This species occurs in India as well as in Ceylon. No specimens are in the collections.

Boiga forsteni (Duméril, Bibron and Duméril)

Pl. XXII, fig. 2

Triglyphodon forsteni Duméril, Bibron and Duméril. Erpétologie Générale, vol. 7, 1854 pp. 1077-1078 (type locality unknown).

Dipsas forsteni Günther, Reptiles of British India, 1864, p. 309; Anderson, Proc. Zool. Soc London, 1871, p. 187; Boulenger Fauna British India . . ., 1890, p. 362.

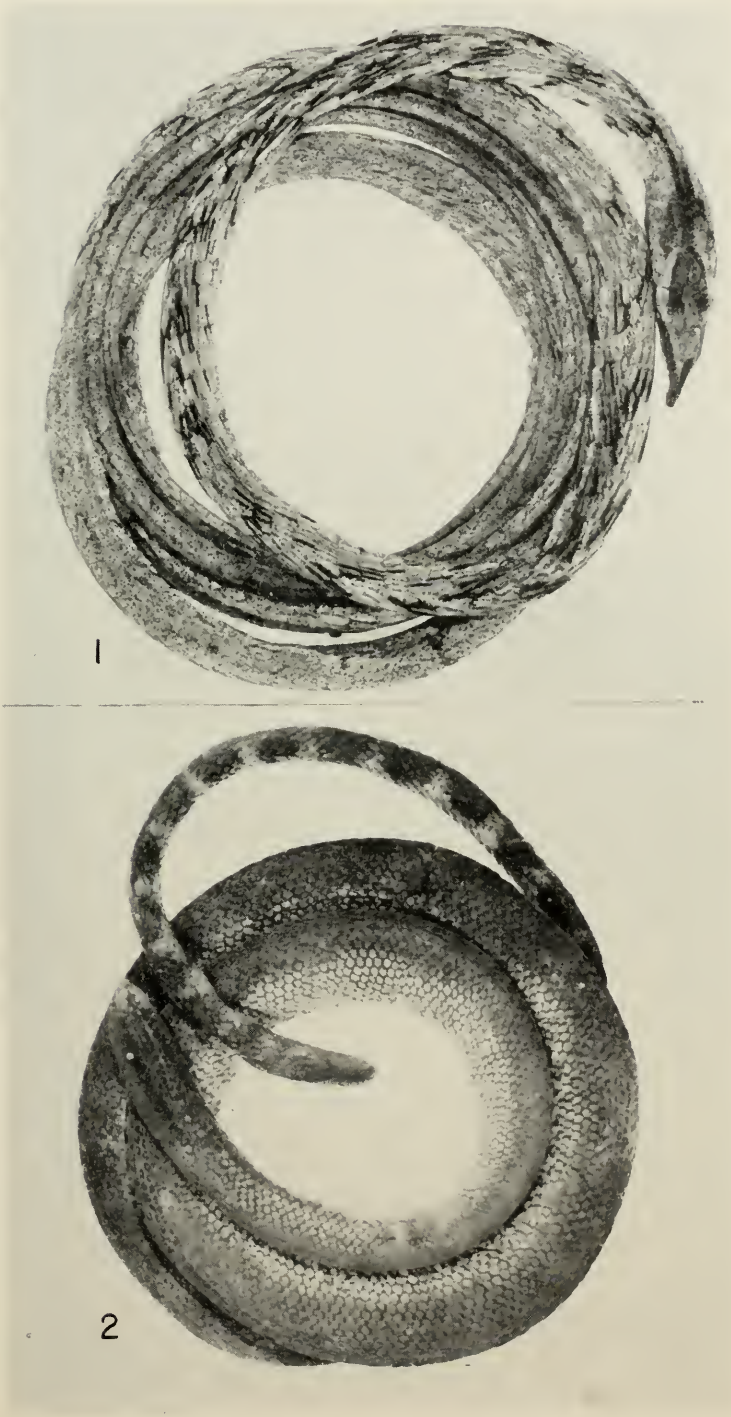
Boiga forsteni Wall, Ophidia Taprobanica or the Snakes of Ceylon, 1921, p. 285; Journ. Bombay Nat. Hist. Soc., 29, 1924, p. 874; Smith, Fauna of British India . . .; Reptilia and Amphibia, vol. 3, Serpentes, 1943, pp. 358-359.

Dipsas forsteni var. *ceylonensis* Anderson, Proc. Zool. Soc. London, 1871, p. 187 (type locality, Ceylon).

Two specimens (EHT-HMS Nos. 30676, 30677) of this species were collected 12 miles north of Trincomalee, Ceylon. Both were obtained in the immediate vicinity of dwellings at night.

The color pattern of the larger specimen is complex. There is a series of dorsal light spots, and a second series alternating with these on the median lateral region. A third series is present still lower on the side which alternates with the second series. On the edges of the ventrals is a fourth series. Anteriorly, the spots of the four series are larger and often contiguous; posteriorly they are narrower and usually separated. Occupying the intervening spaces are areas or spots of brown, many scales of which are black-edged. These spots are usually contiguous. On the ventrals are series of

PLATE XXIII. Fig. 1. *Dryophis pulverulentus* Duméril, Bibron and Duméril. EHT-HMS No. 31245 ♂; 12 miles north of Trincomalee, Eastern Province, Ceylon; total length, 1,322 mm. Fig. 2. *Microcephalophis gracilis* Shaw. EHT-HMS No. 30683 ♂; 12 miles north of Trincomalee, Eastern Province, Ceylon; total length, 760 mm.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small dark spots. Two larger spots on the outer edges of the adjoining scales alternate with two or three spots on scales that are contiguous. The small spots are farther from the outer edges of the scales, and less distinct. A narrow light-edged stripe runs from the frontal to the nape. A broad brown stripe with a black edge runs from the eye to the angle of the jaw. All labials are edged with dark brown.

The scale counts for No. 30676 and No. 30677 are respectively: Ventrals 264, 257; subcaudals 111, 110; scale formula 39-27-29-17, 37-27-28-17; upper labials 9, 10.

GENUS DRYOPHIS Dalman

Dryophis Dalman, Analect. Entomol., 1823, p. 7 (substitute name for *Dryinus* Merrem [preoccupied]).

Genotype, *Coluber nasutus* Merrem.

Two forms, a brilliant green species and a dull brownish to grayish species, occur in Ceylon. They are probably equally numerous; however, the green form is more frequently taken probably due to its more conspicuous coloration.

KEY TO THE CEYLONESE SPECIES OF DRYOPHIS

1. Dermal appendage formed of rostral scale only. Green in color..... *nasutus*
   Ventral surface of the dermal appendage formed by rostral, the upper surface covered with small scales; color brownish or gray with some transverse black marks ..... *pulverulentus*

Dryophis pulverulentus (Duméril, Bibron and Duméril)

Pl. XXIII, fig. 1

Dryinus pulverulentus Duméril, Bibron and Duméril, Erpétologie Générale, vol. 7, pt. 1, 1854, p. 812 (type locality not known).

Dryophis pulverulentus Boulenger, The Fauna of British India . . ., 1890, p. 371; Smith, The Fauna of British India . . ., Reptilia and Amphibia, vol. 3, Serpentes, 1943, p. 378.

Passerita purpurascens Günther, Reptiles of British India, p. 307, pl. 23, F (Ceylon).

This species is represented in the collection by five specimens, EHT-HMS Nos. 30731-30735, all from twelve miles north of Trincomalee, Ceylon.

Smith, *loc. cit.*, gives a lower average of ventrals and subcaudals for Ceylon specimens than for Indian specimens. His counts are, ventrals 179-193; subcaudals 151-178, Ceylon; ventrals 182-203; subcaudals 169-208 for south India.

The smooth scales are arranged in oblique transverse lines, the scale formula being 15-15-13, the median row being enlarged slightly. The dermal appendage on the tip of the snout is as long as the eye diameter.

The general color is brownish when the epidermis is intact or

grayish with epidermal scales removed. A series of more or less distinct darker crossbands are present, becoming indistinct posteriorly on body. These spots are formed by the darker edges of certain scales and the black intervening skin. There is a dark cephalic spot from the prefrontals to the back end of the parietals. An irregularly-edged dark stripe from the anterior end of the first labial to a point just behind the jaw angle. The ventral surfaces are powdered with brown or gray.

The following data gives certain scale variations for the species:

TABLE OF DATA ON *Dryophis pulverulentus*

Number	Sex	Ventrals	Subcaudals	Preocular	Postoculars	Supralabials	Infralabials
30731	♂	183	173	3–3	2–2	8–8	9–9
30732	♀	181	161	3–3	2–2	8–8	10–10
30733	♂	178	165	3–3	2–2	8–8	9–9
30734	♂	183	179	3–3	2–2	8–8	9–9
30735	♂	188	175	3–3	2–2	8–8	9–9

Dryophis nasutus (Lacépède)

Coluber nasutus Lacèpéde, H'stoire Naturelle des Serpents, vol. 1, p. 100, vol. 2, p. 277, pl. 4, fig. ? (type locality, Ceylon, Guinea, Carolina. Here restricted to Ceylon).

Dryophis myctcrizans rhodonotus Wall, Ophidia Taprobanica or the Snakes of Ceylon, 1921, p. 293 ("a beautiful rose-pink dorsally with pinkish-buff ventrally." Galatura Estate, Ceylon, 500-1,000 ft. high).

Dryophis nasutus Smith, The Fauna of British India . . ., Reptilia and Amphibia, vol. 3, Serpentes, 1943, pp. 376-378.

The specimens in the collection are U. S. N. M. Nos. 29428 "Ceylon", and 56419-56420 "Ceylon"; EHT-HMS Nos. 30714-30723, 12 to 15 miles north of Trincomalee, Ceylon. This series has representatives of several color varieties: yellow-green, grayish green, dark green, and lavender. All have the two cream lines on the ventrals and subcaudals, while only a few have also a median pair of white lines. In three cases these white lines continue to the vent; in the others they may be short or they may be absent, or at least not discernible.

GENUS HURRIA Daudin

Hurria Daudin, Bull. Soc. Philom. Paris, vol. 3, no. 72, Mar., 1803, p. 187.
Genotype, *Coluber cerberus*.

It seems that this name takes precedence over *Cerberus* Cuvier (1829 Reg. Anim.), which is used for this species by many herpetologists including Smith, *loc. cit.* See Stejneger, Herpetology of Japan, Bull. 58, 1907, U. S. N. M., p. 304, regarding the status of the two names.

A single species, *Hurria rhynchops* (Schneider), is recognized as occurring in Ceylon. It is widespread in southern and eastern Asia, Malay Archipelago and the Philippines.

Hurria rhynchops (Schneider)

Hydrus rynchops Schneider, Historia Amphibiorum naturalis et literaria, vol. 1, 1799, p. 246.

Cerberus rhynchops Günther, Reptiles of British India, 1864, p. 279.

A specimen (EHT-HMS No. 30682) was captured in a salt water lagoon 13 miles north of Trincomalee, Ceylon. The color is lead with very indistinct darker banding; the ventrals are 147; anal divided; subcaudals 64. The scale formula is (40-27)-23-17. The keels are very strong on the scales, extending to the outermost row. (The outer row is not keeled in a Sumatran specimen at hand.) The labials are atypical in that only the first five are complete, the next five being divided transversely, leaving a series of very large "temporals" between the labials and the normal temporals. The frontal, like the parietals, is broken into a number of scales. The greater part of the three outer scale rows is somewhat pinkish white, forming a stripe, not visible from dorsal view, since three rows are largely on the ventral surface. The specimen has a single preocular (2 in the Sumatran specimen).

The species is a common one in river mouths and lagoons especially near mangrove associations. It also is reputed to enter fresh water.

FAMILY ELAPIDAE

There are three genera of the Elapidae represented in the island of Ceylon. They may be recognized by the following key applicable to Ceylon specimens. All are poisonous and among the more dangerous snakes.

KEY TO THE CEYLONESE GENERA OF THE ELAPIDAE

1. Maxillary bone not extending forward beyond the palatine; scales not oblique, the vertebral series strongly enlarged; neck lacking elongate ribs, and "hood," *Bungarus*

   Maxillary bone extending forward beyond the palatine; vertebral series not enlarged 2

2. Scales in 13-15 rows throughout the body; scales not oblique; neck not dilatable, *Callophis*

   Scales in 15-25 rows on body disposed obliquely; neck with elongate ribs, dilatable, forming a "hood" ..... *Naja*

GENUS BUNGARUS Daudin

Bungarus Daudin, Mag. Encycl., vol. 5, Year 8 (= 1803), p. 434.
Genotype, *fasciatus*.

Two species occur in Ceylon.

KEY TO SPECIES OF BUNGARUS IN CEYLON

1. Lustrous black with a series of paired linear white marks crossing the body; lower parts white; ventrals, 195-225; subcaudals, 37-56..... *caeruleus*

   Black above with from 15 to 21 white crossbars, which are narrow on the vertebral line and widen laterally; may be indistinct in adult; belly white in young; banded black and white in adult; ventrals, 219-236; subcaudals, 32-42, *ceylonicus* *

* This species was inadvertently omitted from the text. No specimens are at hand.

Bungarus caeruleus (Schneider)

Pseudoboa caerulea Schneider, Historia Amphibiorum naturalis et literaria, 1799-1801, p. 284 (Based on Russell's An Account of Indian Serpents . . ., vol. 1, p. 2, pl. 1) (type locality, Vizagapatam, India).

Bungarus caeruleus (part) Boulenger, Fauna of British India . . ., Reptilia and Batrachia, 1890, p. 388; Wall, Ophidia Taprobanica or the Snakes of Ceylon, 1921, pp. 437-451.

One specimen is at hand, KUMNH No. 24140, taken at Negombo, Western Province, Ceylon, by W. C. Osman-Hill.

The specimen is young, measuring 321 mm. in total length; the tail 36 mm.

The head is dark above, light on supralabials; a partial white band across back of head. The general color of body is gray-brown crossed by about 41 narrow transverse cream bands widening a little low on sides. At the anterior end of the body these are rather widely separated; at the fourth there is a pair of light lines separated by one or two scale rows that cross the body separating wider intervening dark blotches; farther back these white lines are farther apart until the white bands are separated by distances approximately equal to the intervening dark blotches. However they differ from the intervening bands in having the vertebral scales, or at least some part of the vertebrals, cream in color. The venter is uniformly white. The bands are obsolete on the tail. The ventrals are 208; the subcaudals 41, all single save one or two pairs near the extreme tip. The anal is single. The scale formula is 19(17)-15-15.

The head has been partially destroyed, presumably by ants, and all the characters cannot be determined.

GENUS CALLOPHIS Gray

Callophis Gray, Illustrations of Indian Zoology, vol. 2, 1834, pl. 86, fig. 1 (type *Callophis gracilis*).

Callophis Günther, Proc. Zool. Soc. London, 1859, p. 79.

Only a single species is known from Ceylon.

Callophis melanurus (Shaw)

Coluber melanurus Shaw, General Zoology, vol. 3, 1802, p. 552 (based on Russell's Indian Serpents, vol. 1, 1796, p. 12, pl. 8) (type locality, Nerva, Bengal); Smith, Fauna of British India, Ceylon and Burma . . ., Reptilia and Amphibia, vol. 3, Serpentes, 1943, p. 420.

Callophis trimaculata Wall, Ophidia Taprobanica or the Snakes of Ceylon, 1921, pp. 497-501, fig. 90.

Two specimens of this rare snake were obtained by H. G. Diegnan at Clodagh Estate, Rattota, Matale District, Ceylon (U. S. National Museum Nos. 120334, 120335. Wall reports 7 other specimens from the island.

Description: Rostral one third or more, wider than long, the part visible above about two thirds of the prefrontal suture; internasals

one third wider than long, their mutual suture less than half the prefrontal suture; prefrontals slightly longer than wide; frontal length four fifths of the distance from tip of snout; parietals very large, their length greater than their distance from the end of the snout, and twice as great as their width; anterior seminasal higher than wide, almost inclosing the nostril, much larger than posterior; preocular very large, longer than high; supraocular rather small, one half or less the area of the anterior temporal, which touches only the lower of two postoculars; six supralabials, the order of size being 1, 2, 4, 5, 3, 6, three scales touching the nasals, third and fourth entering orbit, fifth touching lower postocular, sixth as long as the temporal, but narrower; an enlarged secondary temporal also borders the parietal.

Diameter of eye a little less than its distance from the commisure of mouth. Mental very little narrower than rostral; anterior chinshields one fourth longer than posterior chinshields; six infralabials, first four touching the anterior chinshield, the fourth very large; posterior chinshields separated from the first ventral by four scales.

Thirteen scale rows from head to anus; seven or eight about base of tail. Ventrals 231, the first divided; 28 divided subcaudals; anal divided; no apical pits; under magnification scales appear finely striated. Maxillary with a single fang, but no other teeth apparent.

Coloration. Above generally gray-brown with 19 transverse bands of black on the dorsum, these sometimes complete, sometimes broken mesially and the opposite half occasionally displaced. The spot on neck somewhat heavier than others; two black bands encircle the tail; the ventral surface bluish gray with six small black spots arranged more or less symmetrically; venter, fawn on under side of neck, gradually becoming darker salmon orange to pinkish on later fifth of body; outer one or two scale rows somewhat fawn, merging into dorsal and ventral color.

Top of head nearly uniform brownish. A diffuse blackish spot about eye, extending along lower part of labials to a blackish spot near angle of mouth but enclosing a roundish cream spot which covers parts of three scales, but is chiefly on the anterior temporal; this followed by a lateral cream area extending from throat; nuchal dark band curving back is more or less connected with dark area at angle of mouth. Occasional dark flecks, usually confined to median row or third outer row.

A young specimen, U. S. N. M. No. 120334, from the same local-

ity agrees in almost all details of squamation. The posterior chinshields are proportionally larger, nearly equalling the size of the anterior. There are 223 ventrals, and 37 subcaudals. There are 16 dorsal transverse body spots (some broken) with two on tail, both of which are interrupted ventrally. The colors are faded. The spotting on the third outer scale row is a little more regular and there are more of the scattered dark flecks. The small subcaudal spots are not evident. The flecks on the dorsal scales tend to form lines. The head is a very light brown with only minute flecks. The eye spot and the spot at the angle of the mouth are very diffuse, scarcely discernible without a lens. The neck band is black.

There are certain obvious differences between the specimens here described and descriptions given of Indian specimens. Thus there are marked differences in head coloration, the type and others are described as having a black head and neck; with a pair of yellow spots on the occiput. The Ceylon adult loses the series of lines on the back and they are scarcely evident in the young; Smith states that the under part of the tail is red, while Wall, perhaps speaking of Ceylon forms mentions the color as pearly gray or pale bluish. The Indian species is regarded as small (about a foot long). The larger of these two specimens is approximately 437 mm. (approximately 17½ inches) suggesting that it is a larger form than the Indian species. Moreover there is a smaller number of ventrals (when sexes are compared) in the island specimens. While I believe the Ceylonese form worthy of subspecific designation, material as yet is too scanty to delimit the form.

GENUS NAJA LAURENTI

Naja Laurenti, Specimen medicum exhibens Synopsin Reptilium emendatum, 1768, p. 90. Genotype: *Coluber naja* Linnaeus.

Naja naja naja (Linnaeus)

Pl. XXIV, fig. 2

Coluber naja Linnaeus, Systema Naturae, 10th ed., 1758, p. 221. (Based on Seba, Thesaurus, vol. 1, 1734, pls. 44, 85, 89, 90, 97 [*part.*]) (type locality, India).

Naja naja polyocellata Deraniyagala, Ceylon Journ. Sci., sec. B, vol. 21, 1939, p. 233 (type locality, Polonnaruva, N. Central Province, Ceylon).

Naja naja naja Smith, The Fauna of British India . . ., Reptilia and Amphibia, vol. 3, Serpentes, 1943, pp. 428, 431; Deraniyagala, Spolia Zeylanica, vol. 24, pt. 2, 1945, p. 109.

Deraniyagala (*loc. cit.*) has limited the distribution of the subspecies *Naja naja naja* to the island of Ceylon, and has applied names to certain Indian forms. While it is almost certain that there are forms worthy of names occurring on the continent, Deraniyagala suggests that since he has not been able to consult the "various rare

old publications containing the different descriptions of *Naja*" some of the names may not be correctly applied by him. In view of the possibility that the name *lutescens,* which he applied to a peninsular race, may be applicable to a northern race, he suggests an alternative name, *Naja naja madrasiensis* for the same. Smith, *loc. cit.*, regards *Naja naja naja* as extending throughout much of peninsular India.

The chief structural character offered by Deraniyagala in separation of the Ceylon forms seems to be in the position of the opening of the poison groove. In *N. n. naja* it is well above the apex, in the nearest continental form the outlet is said to open at the apex. The markings differ in details.

There are four specimens in the collections from Ceylon: U.S.N.M. No. 120333, Peradeniya, Kandy District, Ceylon; EHT-HMS Nos. 30702-30704, 12 miles north of Trincomalee, Ceylon.

All are the typical "spectacled" cobras. They vary somewhat in the number and distinctness of the black bars across the venter, which may or may not be traceable across the dorsum and the markings vary with age. The scale characters of the four specimens are recorded in the following table.

TABLE OF DATA ON CEYLONESE SPECIMENS OF *Naja naja naja*

Number	Sex	Ventrals	Sub-caudals	Supra-labials	Infra-labials	Scale rows
30702	♂	185	57	7–7	9–9	35, 23, 23, 15
30703	♀	187	59	7–7	8–8	35, 23, 23, 15
30704	♀	192	60	7–7	8–8	35, 23, 23, 15
120333	♀	188	60	7–7	8–8	33, 23, 23, 15

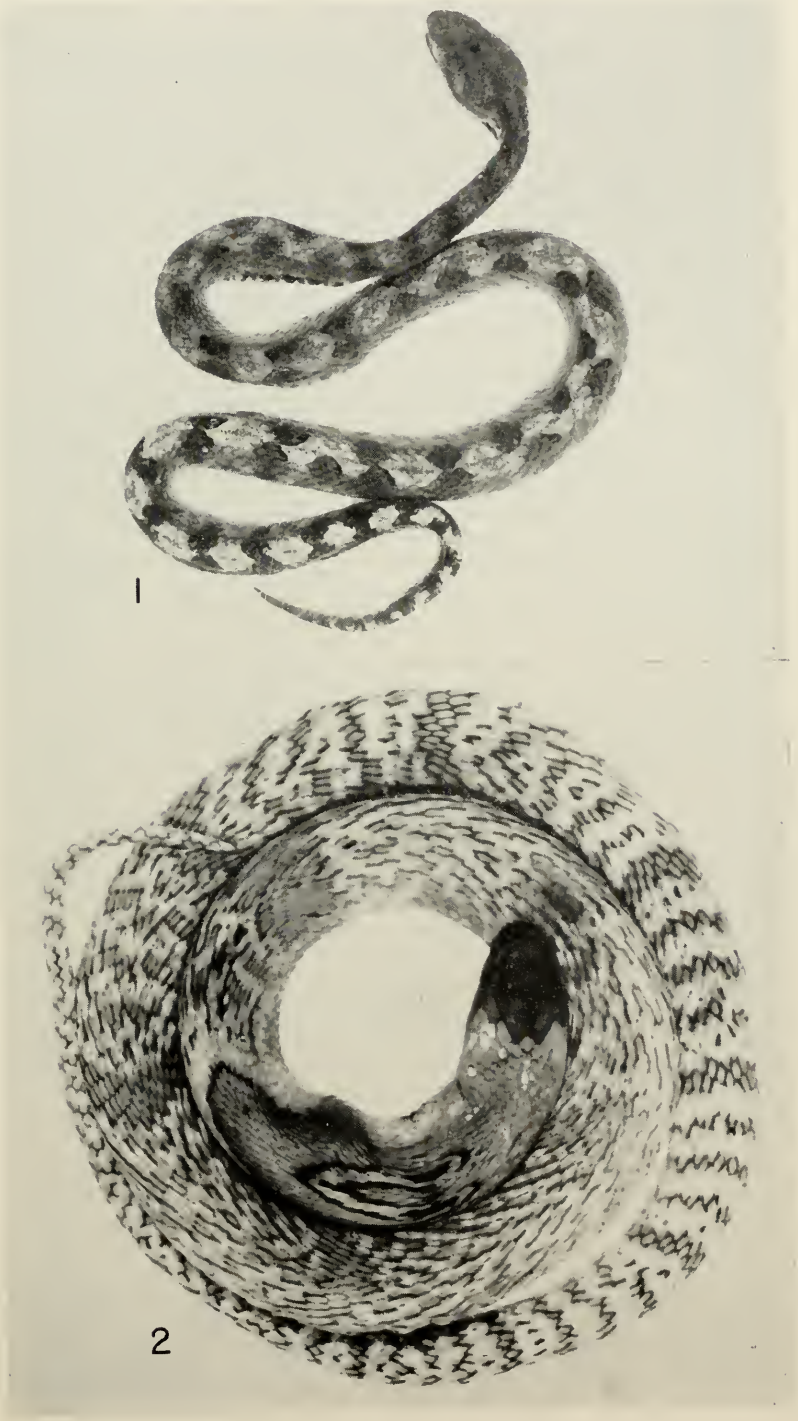
Three first labials touch the posterior nasal; the temporals are 2-3 (in one specimen a small scale makes a count of 2-4). In No. 30702 there is a very small triangular labial between the fourth and fifth labials. It presumably is a segmented portion from the fourth.

The number of black marks across the venter can be determined with difficulty in older specimens. They vary in width; the first and third or first, second and third being usually widest.

FAMILY HYDROPHIIDAE

Ceylon has known representatives of several genera of the sea snakes, and it is probable that others, not yet reported also occur. Wall, in his Ophidia Taprobanica, has listed 22 species under 16

PLATE XXIV. Fig. 1. *Agkistrodon hypmale* (Merrem). EHT-HMS No. 30691 ♀ ; 12 miles north of Trincomalee, Eastern Province, Ceylon; total length, 354 mm. Fig. 2. *Naja naja naja* (Linnaeus). EHT-HMS No. 30702 ♂ ; 12 miles north of Trincomalee, Eastern Province, Ceylon; total length, 936 mm.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genera. I have found authentic records of only the following genera: *Kerilia, Hydrophis, Lapemis, Astrotia, Pelamis* and *Microcephalophis.*

These may be distinguished by the following key.

KEY TO CEYLONESE GENERA OF THE FAMILY HYDROPHIIDAE

1. Ventrals distinct throughout length, normally entire, not divided 2
   Ventrals, except near anterior part of venter, either divided medially by a longitudinal fissure or vestigial (smaller than adjacent scales or absent) 3
2. Scales normal, imbricating, not more than 23 rows around the body, not quadrangular or juxtaposed ..... *Kerilia*
   Scales tending to be quadrangular, or hexagonal, juxtaposed, not or scarcely imbricating; more than 25 scales around body ..... *Hydrophis*
3. Head very small, the greatest diameter of body four or five times that of the neck; the neck and anterior third or two fifths of body very slender, posterior part compressed and deepened ..... *Microcephalophis*
   Head not especially small, the diameter of the neck one third or less that of the greatest body diameter 4
4. Dorsal scales pointed strongly imbricate; ventrals divided into two halves; large species, of large girth ..... *Astrotia*
   Dorsal scales juxtaposed, subquadrangular in shape 5
5. Ventrals when distinct with a longitudinal fissure; dorsal coloration nearly uniform; lateral and ventral coloration lighter (whitish yellow) with or without a longitudinal darker or lighter lateral line; lower scale rows not larger than others, *Pelamis*
   Ventrals when present more or less divided; lower three or four rows of lateral body scales larger than others ..... *Lapemis*

GENUS KERILIA Gray

Kerilia Gray, Catalogue of the Snakes in the British Museum, 1849, p. 57.
Genotype, *Kerilia jerdoni.*

Only a single species known.

Kerilia jerdoni jerdoni Gray

Kerilia jerdoni Grey, Catalogue of the Snakes in the British Museum, 1849, p. 57 (type locality, Madras); Smith, The Fauna of British India . . .. Reptilia and Amphibia, vol. 3, Serpentes, 1943, pp. 446-447, fig. 143.

There is no specimen present in the collection.

This species of sea snake may be diagnosed by the following characters: large imbricating scales; head shields of the normal number except loreal absent; scales in 19-23 rows; one preocular, one postocular; ventrals narrow; six supralabials, anterior temporal, one; ventrals 225-253. Body of equal diameter throughout. Dark bands encircle the body in the young and may be retained in adults.

GENUS HYDROPHIS Latreille

Hydrophis Latreille, Histoire Naturelle des Reptiles, vol. 4, 1802.
Genotype, *fasciatus.*

Only three of the numerous species of this genus have been reported in Ceylon. These are *cyanocinctus, bituberculatus* and *lapemoides.*

These three forms may be distinguished by the following synopsis.

KEY TO CEYLONESE SPECIES OF HYDROPHIS

1. Scales on the deepest part of the body with rounded or indistinctly pointed tips, distinctly or feebly imbricate; 5-8 solid maxillary teeth behind the fangs; body elongate 2

   Scales on thickest part of body subquadrangular or hexagonal in shape, juxtaposed, nonimbricate; 8 to 18 maxillary teeth behind fangs; two anterior temporals; 29-35 scale rows on the neck; ventrals, 314-372; head with a curved yellow mark in young, lost or indistinct in adults..... *lapemoides*

2. One anterior temporal; body uniform gray 7 or 8 solid maxillary teeth behind fangs; greatest diameter of head four times that of neck; scales, 27-48; ventrals, 276 ..... *bituberculatus*

   Two anterior temporals; body banded with annuli; 5 or 6 solid maxillary teeth behind fangs; diameter of head at most two and one-half times that of neck, *cyanocinctus* .

Hydrophis cyanocinctus Daudin

Hydrophis cyanocinctus Daudin, Histoire Naturelle des Reptiles, vol. 7, 1803, p. 383 (Based on Russel's An Account of Indian Serpents, vol. 2, p. 10, pl. 9) (Sandarbans).

See characters in Key. No specimens in the collection.

Hydrophis bituberculatus Peters

Hydrophis bituberculatus Peters, Monatsb. Akad. Wiss. Berlin, 1872, p. 855 (type locality, Colombo, Ceylon).

No specimens in the collection. The species is known from a single specimen.

Hydrophis lapemoides (Gray)

Atuira lapemoides Gray, Catalogue of the Specimens of Snakes in the Collection of the British Museum, 1849, p. 46 (type locality, Ceylon, Madras. Here restricted to Ceylon).
Hydrophis lapemoides Smith, Monograph of the Sea Snakes, 1926, p. 86.

No specimens in the collection.

GENUS MICROCEPHALOPHIS LESSON

Microcephalophis Lesson, In Belanger, Voy. Ind. Orient, 1834, p. 320.
Genotype, *gracilis*.

Of the two species recognized, only one has been recorded from Ceylon.

KEY TO THE SPECIES OF MICROCEPHALOPHIS

Prefrontal not touching the third supralabial; ventrals, 220-350..... *gracilis*
Prefrontal touching the third supralabial; ventrals, 404-468..... *cantoris*

Microcephalophis gracilis gracilis (Shaw)

Pl. XXIII, fig. 2

Hydrus gracilis Shaw, General Zoology, vol. 3, 1802, p. 560.
Microcephalophis gracilis Wall, Ophidia Taprobanica or the Snakes of Ceylon, 1921, pp. 325-330, fig. 62; Smith, Monogaph of the Sea-snakes (Hydrophiidae), Nov. 27, 1926, pp. 121-213, fig. 34, skull; and Fauna British India including Ceylon and Burma, etc.; Reptiles and Amphibia, vol. 3, Serpentes, pp. 325-330, fig. 62, A-D.

I collected this species from the beach 12 miles north of Trincomalee, Ceylon (EHT-HMS No. 30083). The specimen was very active

but wholly unable to make any progression on the wet sand. It had been stranded by a small wave, and when found was less than four feet from the edge of the water.

This species is regarded as rare throughout most of the wide area where it occurs. Smith (Monograph) reports a Ceylon specimen, and Wall (*loc. cit.*) mentions four specimens in the Colombo Museum, presumably from Ceylon. He reports it as common on the Malabar and Coromandel Coasts of India, and gives its range as extending from the Persian Gulf to Japan. An Australian record needs further confirmation since it has not been recorded in the intervening territory. The other species of the genus (*M. cantoris*) is unknown as yet in Ceylonese waters.

The arrangement of head scales conforms to Wall's figure save that the rostral is higher and the width of the rostral one third greater. The ventral count is 233, the subcaudals 38. The latter part of the body is extremely compressed, the dorsal part forming a sharp crest. The anterior narrowed part however is nearly cylindrical. The depth of the head at the mouth angle (5.3 mm.) is contained in the greatest body depth (22 mm.) about four times. There are 31 scales around the neck (33 counting the divided ventrals), and 29 a centimeter in front of the anus.

Several small barnacles are fastened to the scales of the specimen.

Smith has recognized a subspecies of *gracilis* on the coast of the Malayan Peninsula and Java.

GENUS ASTROTIA Fischer

Astrotia Fischer, Abh. Naturw. Ver. Hamburg, vol. 3, 1856, p. 38.
Genotype, *schizopholis* = *stokesi*.

Only a single species known.

Astrotia stokesii (Gray)

Hydrus stokesii Gray, In Stokes' Discovery of Australia, vol. 1, p. 502, pl. 3.
Astrotia stokesii Wall, Mem. Asiat. Soc. Bengal, vol. 2, 1909, p. 250; Ophidia Taprobanica . . ., 1921, p. 396; Smith, The Fauna of British India . . ., Reptilia and Amphibia, vol. 3, Serpentes, 1943, pp. 471-472.

This, the largest of the sea serpents, is known from the western coast of Ceylon. No specimens are in the collection.

This form may be recognized by the character of the ventral scales. These are divided in two, except anteriorly, and the halves are pointed or with a dentate tip. The ventrals are 226-286, the preanals strongly enlarged. The diameter of the neck is more than half the greatest body diameter. One preocular and two postoculars are present. The supralabials are 8-10, the infralabials 10-12. The

scale rows vary between 37 and 47 on the neck, and 47-59 on the body.

The color is "yellowish or pale brown, with broad black or dark brown bands more or less complete, or with dorsal bars and ventral spots. Spots or narrow bars often present between the annuli. Head dark olivaceus to yellowish."

The species reaches a length of at least 1600 mm. and the girth of a large specimen may exceed 260 mm.

GENUS PELAMIS Daudin

Pelamis (in part) Daudin, Histoire Naturelle, Générale et Particulière des Reptiles (1803), Year XI, vol. VII, pp. 357, 361, 362.

Genotype, *Anguis platurus*.

Only one species is generally recognized. It is one of the most widely distributed of all snakes. There are a number of so-called color varieties.

Pelamis platurus (Linné)

Anguis platurus Linné, Systema Naturae, ed 12, 1766, p. 391.

Pelamis platurus Gray, Ann. Philos., 1825, p. 15; Smith, Monograph of the Sea-snakes (Hydrophiidae), Nov. 27, 1926, pp. 116-120, fig. 33; Smith and Taylor, U. S. Nat. Mus. Bull., No. 187, 1945, pp. 176-177.

The puzzling variety of color patterns and the remarkable variation in scale rows and ventral scale counts suggest strongly that the assemblage of forms now placed under this specific designation represents more than a single species. The scale rows reputedly vary from 49-67 rows, a difference of 18 rows. The ventral scales vary between 264-406, a difference of 142. Few if any other snakes have scale variations of this magnitude.

Specimens are at hand from Ceylon belonging to two or three well-marked color forms.

U. S. Nat. Mus. No. 19213 is a specimen in which the body is blackish above (faded), and yellowish below, the black beginning on the head in the region of the nostrils and extending along the dorsum in a band 11 scale rows in width, for about one third the length of the body. Where this ends, there begins a series of transverse bands, contiguous mesially and extending down on the sides. Posteriorly the dorsal parts are separated. There are no lateral spots save on the tail where small spots intervene on the sides between the bands.

U. S. Nat. Mus. No. 31212 has the black coloration forming a series of spots contiguous on the median dorsal line. Posteriorly the spots are rhomboidal, extending rarely half way down the side. The intercalated spots may be distinguished by their being lower on the

sides of the tail. This specimen, although a shorter specimen than the preceding one, has the nostrils distinctly farther back from the tip of the snout.

A third specimen from the northeast coast, 12 miles north of Trincomalee, is coal-black on the dorsal 25 scale rows, and dirty, grayish lavender on the ventral part of the body save for an indistinct lighter line separating the two colors. The labials are not lighter than the ventral coloration. The tail is clear pinkish white with a series of transverse coal-black bands, contiguous or not, dorsally, and a series of black spots alternating with them on each side. In front of and behind the vent there is a deep black spot.

The ventral-subcaudal scale counts for Nos. 31213, 31212 and 31250 are, respectively, 334-44, 369-52, 360-55; and the midbody scale rows are, respectively, 58, 51, 58. The four preanals in No. 31212 are reduced to the size of other ventral scales and the scales preceding these are not enlarged.

Thus if one considers these variant forms as worthy of names, they must be regarded as species rather than subspecies.

GENUS LAPEMIS Gray

Lapemis Gray, Illustrations of Indian Zoology, chiefly selected from the collection of Major-General Hardwicke, vol. 2, 1835, pl. 87, fig. 2.

Genotype, *Lapemis curtus* Shaw.

Two species are known.

Lapemis curtus Shaw

Lapemis curtus Shaw, General Zoology, vol. 3, 1802, p. 562 (type locality not given).

A single specimen, EHT-HMS No. 30678 ♀, was taken on the shore of the Bay of Bengal, 13 miles north of Trincomalee. The following scale characters obtain: frontal shorter than its distance from rostral; parietal broken into three or four unequal scales; one preocular, one postocular; seven supralabials, the two last very small; second supralabial bordering the prefrontal; fourth only bordering orbit; two large anterior temporals, two posterior temporals; three infralabials border the chinshields; both pairs of chinshields separated by one or two scales.

The scale rows counted at various points on body are 35-37-30-40-33; scales more or less quadrangular, juxtaposed; ventrals 195, more or less distinct throughout; subcaudals 45 (scales in a row on lower edge of tail).

Head normal, the body greatly thickened and laterally compressed; at its greatest depth approximately three times depth of

neck; back with a moderately sharp ridge; gray with 58 bands across the back separated by one or two scales on the median dorsal line and coming to a point low on side; below these and on venter yellowish buff.

FAMILY VIPERIDAE

The family consists of two subfamilies, Viperinae and Crotalinae.

SUBFAMILY VIPERINAE

This subfamily is represented in Ceylon by two genera, *Echis* and *Vipera*, each represented by a single species.

GENUS VIPERA Laurenti

Vipera Laurenti (part), Specimen medicum, exhibens Synopsin Reptilium emendatum, 1768, p. 99.

Genotype, *redi* = *aspis*.

Vipera russelli russelli (Shaw)

Coluber russelli Shaw, Naturalists Miscellany vol. 8, pl. 291 (1797) (type locality, India, by inference).

Vipera russelli Strauch, Mem. Acad. St. Petersburg, 7, XIV, No. 6, p. 85; Wall, Ophidia Taprobanica or the Snakes of Ceylon, 1921, p. 504.

Vipera russelli russelli Smith, The Fauna of British India . . ., Reptilia and Amphibia, vol. 3, Serpentes, 1943, p. 483.

Two specimens (U. S. Nat. Mus. No. 115611 and EHT-HMS No. 30679) are at hand, the latter taken 12 miles north of Trincomalee, Ceylon. I have the skin of a fine specimen (EHT-HMS No. 31254) presented to me by Major General Richardson. It was killed by him in his yard in Trincomalee.

This snake is not rare in this part of Ceylon. Several dead specimens were seen along the road.

The species is not aggressive. Usually, when disturbed, it hisses rather loudly.

GENUS ECHIS Merrem

Echis Merrem (*part.*), Tentamen Systematis Amphibiorum, 1820, p. 49.

Genotype, *Echis carinata*.

Echis carinatus Schneider

Pseudoboa carinata Schneider, Historia Amphibiorum naturalis et literaria, vol. 2, 1801, p. 285 (species based on Russel, An Account of Indiana Serpents . . .)

Echis carinata Fayrer, The Thanatophidia of India . . ., 1874, pl. 12; Wall, Ophidia Taprobanica or the Snakes of Ceylon, 1921, pp. 529-547, figs. 93-95.

No Ceylonese specimens of this species are in the collection. I have taken it in the city of Bombay.

In Ceylon the species is known only from the extreme northern part and may be of relatively recent introduction. It is a small

snake that has the habit of producing a curious rasping sound. The scales have a sawlike crest or keel which when rubbed together produce the sound.

SUBFAMILY CROTALINAE

This subfamily is represented by two genera, *Agkistrodon* and *Trimeresurus* the first with two, the second with one species.

GENUS TRIMERESURUS Lacépède

Trimeresurus Lacépède, Ann. du Mus. Paris, vol. 4, 1804, pp. 196, 209 (part). Genotype, *Trimeresurus viridis*.

This genus name as applied to Asiatic forms, is, I believe, composite, as is the name *Bothrops* as applied to related groups of pit vipers in Mexico, Central and South America.

Only a single species is known from Ceylon.

Trimeresurus trigonocephalus (Sonnini and Latreille)

Vipera trigonocephala, Sonnini and Latreille, Histoire Naturelle des Reptiles, vol. 3, 1801 (1803?), p. 175 (type based on Seba, Thesaurus, vol. 2, pl. 36, No. 2 [said to be from the Island of St. Eustace]); Daudin, Histoire Naturelle Générale et Particulière des Reptiles, vol. 6, year XI (1803), pp. 175-177.

Cophias trigonocephalus Merrem, Tentamen Systematis Amphibiorum, 1820, p. 156.

Megaera trigonocephala Wagler, Natürliches System der Amphibien, 1830, p. 174; Gray, Zoological Miscellany, 1842, p. 49; Kelaart Prodromus Faunae Zeylanicae, being Contributions to the Zoology of Ceylon, vol. 1, 1853, p. 142; and *idem*, vol. 2, pt. 7, 1854, p. 8 (*trigonocephala*).

Trigonocephalus nigro-marginatus Kuhl, Beitrage Zool., 1832 (1820), p. 90; Schlegel, Essai sur la Physionomie des Serpens, 1837.

Bothrops nigro-marginatus Duméril, Bibron and Duméril, Erpétologie Générale, vol. 7, pt. 2, pp. 1515-1517.

Megaera olivacea Gray, Zoological Miscellany, 1842, p. 12 (type locality not known); and Catalogue of the specimens of Snakes in the collection of the British Museum, 1849, p. 12.

Trimeresurus trigonocephalus Günther, Reptiles of British India, 1864, p. 390; Theobald, Descriptive Catalogue of the Reptiles of British India, 1876, p. 223; Boulenger, The Fauna of British India, including Ceylon and Burma; Reptilia and Batrachia, 1890, p. 431; Werner, Abh, Vehr, Zool. Bot. Ges. Wien, vol. 43, 1893, p. 352; and Sitzb. Vehr. Zool. Bot. Ges. Wien, vol. 46, 1896, p. 10; Abercromby, The Snakes of Ceylon, 1910, pp. 49, 69; and Spoilia Zeylanica, vol. 7, 1911, p. 207; *idem ibid.*, p. 304; Wall, Ophidia Taprobanica or the Snakes of Ceylon, 1921, pp. 560-564, fig. 98 (head); Journ. Bombay Nat. Hist. Soc., vol. 30, 1925, p. 249; and Poisonous Snakes of India, 1928, p. 50; Smith, The Fauna of British India including the whole of the Indo-Chinese subregion; Reptilia and Amphibia, vol. 3, Serpentes Dec., 1943, pp. 506-507.

Lachesis trigonocephalus Boulenger, Catalogue of the Snakes in the British Museum (Natural History), vol. 3, 1896, p. 559; Pearless, Spoilia Zeylanica, 1909, p. 54 (Badula).

One specimen (No. 5894) is present in the U. S. National Museum Collection.

Scale rows are 26-21-19-15; supralabials 10-11; infralabials 12; one or two pairs of suboculars separate the labials from the eye; ventrals 147, the terminal ventral divided forming two scales deeply notched between; anal single; subcaudals, 58, double. The supraocular is divided, and separated from those of the opposite side by five irregular scale rows.

The skin is dark, approaching coal black near the dorsal surface. Most of the scales are some shade of green with black areas with elongate extensions. This series of markings may be more or less connected. Upper part of head greenish, the scales often partially black-edged. A broad black stripe present from eye to mouth angle. The supralabials are yellow, with a dark line crossing below eye; the ventrals are yellowish or greenish, edged with yellowish. The under side of head is yellowish. The tail is black at the tip.

GENUS AGKISTRODON Beauvois

Agkistrodon Beauvois, Trans. American Phil. Soc., vol. 4, 1799, p. 381.
Genotype, *Agkistrodon mokasen*.

Two forms of this genus are recognized in Ceylon. These may be differentiated by the following key.

KEY TO CEYLON SPECIES OF AGKISTRODON

A. Hump on snout tip occupies only the middle of the tip; ventrals, 120-135; subcaudals, 28-30; 380 mm. in total length ..... *nepa*
B. Hump on snout tip occupies the whole of the tip; ventrals, 138-157; subcaudals, 32-46; 545 mm. in total length ..... *hypnale*

Agkistrodon nepa (Laurenti)

Coluber nepa Laurenti, Specimen medicum, exhibens Synopsin Reptilium emendatum, 1768, p. 97 (based on Seba, vol. 1, pl. 19, fig. 7) (type locality, erroneously "Madagascar").

Hypnale nepa Günther, Reptiles of British India, 1864, p. 394 (*part.*).

Ancistrodon nepa Smith, Journ. Bombay Nat. Hist. Soc., vol. 39, 1937, p. 730; and Fauna of British India, Ceylon and Burma including the whole of the Indo-Chinese subregion: Reptilia and Amphibia, vol. 3, Serpentes, 1943, pp. 500-501, Ceylon (Hagkalla, Kandy, Ambewela, Mudulkale).

Ancistrodon hypnale Boulenger, The Fauna of British India including Ceylon and Burma, 1890, p. 424 (*part.*).

Ancistrodon millardi Wall, Ophidia Taprobanica or the Snakes of Ceylon, 1921, p. 554, fig. (not *millardi*, Wall, 1908); Journ. Bombay Nat. Hist. Soc., vol. 30, 1925, p. 249.

I have examined two specimens, KUMNH Nos. 24142, 24143 (which lack exact locality data). These have the following scale counts respectively: Ventrals 140-139; subcaudals 42-36; anal single in both. The scale formula in each is 17-17-15.

The rostral is strongly elevated, at least two fifths extending above the surface of the snout. The posterior side of the elevation is covered with some 15 small scales. The area in front of the frontal is occupied by 16 imbricating scales. The frontal, supraoculars, and parietals are normally large and unbroken. The supralabials are 7-7; the infralabials 8, 8, with only three touching first chinshields. The color above is brown or fawn with indistinct darker marks on each side that sometimes are fused on the middorsal line. The venter is thickly peppered with dark pigment.

Agkistrodon hypnale Merrem

Pl. XXIV, fig. 1; Pl. XXV

Cophias hypnale Merrem, Tentâmen Systematis Amphibiorum, 1820, p. 155.

Trigonocephalus hypnale Schlegel, Essai sur le Physionomie des Serpens, 1837, p. 550, pl. 20, fig. (type locality, "Ceylon").

Trimeresurus ? ceylonensis Gray, 1842, Zoological Miscellany, 1842, p. 49 (Ceylon).

Hypnale nepa Günther, Reptiles of British India, 1864, p. 394 (*part*).

Hypnale affinis Anderson, Journ. Asiatic Soc. Bengal, 40, pt. 2, 1871, p. 20 (Ceylon).

Ancistrodon hypnale (*part*) Boulenger, The Fauna of British India including Ceylon and Burma; Reptilia and Batrachia, 1890, pp. 424-425; Catalogue of the Snakes in the British Museum of Natural History, 2d ed., vol. 3, 1896, p. 76; Wall, Spolia Zeylanica, vol. 3, pt. 10, Oct., 1905, pp. 146-147; *ibid.*, vol. 11, 1920, p. 403; *ibid.*, vol. 12, 1924, p. 270; Journ. Bombay Nat. Hist. Soc., vol. 30, 1925, p. 248; Ophidia Taprobanica or the Snakes of Ceylon, 1921, pp. 549-554, fig. 96 (head); Pearless, Spolia Zeylanica, vol. 6, pt. 21, Mar., 1909, p. 55; Abercromby, *ibid.*, vol. 8, pt. 32, 1913, pp. 304-305 [It is possible some of the references of Wall, Peerless and Abercromby may refer to *A. nepa*]; Smith, The Fauna of British India, Ceylon and Burma including the whole of the Indo-Chinese subregion; Reptilia and Amphibia, vol. 3, Serpentes, 1943, pp. 499-500.

The adult males and females differ considerably in color, that of the female being very much lighter in shade, with the dark markings usually more intense and more strongly contrasting.

The general dorsal coloration is lavender-brown with dim or well-defined brown or blackish markings. The light areas on the back tend to separate the dark spots. A dark line, more or less distinct runs from the eye to the angle of the mouth, where it may continue back along the edge of the ventrals for some distance as a narrow black line, continuous or more usually broken. A white or cream line usually borders the upper edge of the dark line on the head and this may follow along the anterior edge of the ventrals as a series of broken irregular white flecks. On the outer scale row alternating scales usually have small black dots.

Variation in scale counts are recorded in the accompanying table.

Specimen No. 30753 contained 9 embryos. These were well advanced and scale counts were made on the lot. The ventrals and subcaudals are: 146-38, 148-36, 149-36, 150-39, 152-38, 150-36, 151-38, 149-42, and 149-44. The last two are male specimens and have the hemipenis extruded. The others are presumably females. Thus the range for the brood is 146-152 for ventrals; 36-44 for subcaudals. A single male specimen in the United States National Museum from an unknown Ceylon locality has 151 ventrals and 44 subcaudals.

In the species the anal scales are invariably undivided, and there are three preoculars, one subocular and one postocular.

The species was found to be the most common terrestrial snake in the region about Trincomalee. Specimens were discovered ensconsed under logs, under small piles of trash, or crawling about

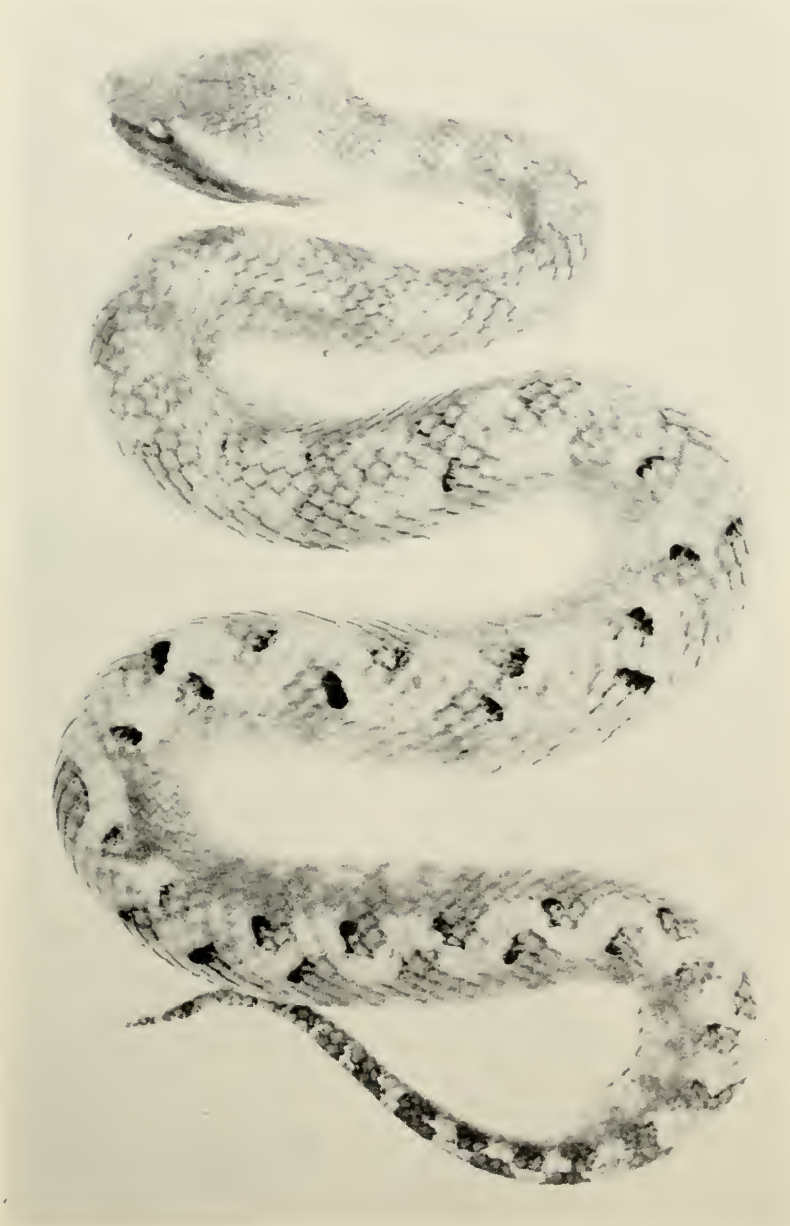

PLATE XXV. *Agkistrodon hypnale* (Merrem). EHT-HMS No. 30687 ♀; 12 miles north of Trincomalee, Eastern Province, Ceylon; total length, 434 mm.

during the day or night on the forest floor. They were slow to anger and only struck when teased or injured. It is not regarded as a dangerous snake by the natives.

SCALE COUNTS OF *Agkistrodon hypnale*

EHT-HMS No.	Sex	Ventrals	Caudals	Scale formula	Upper labials	Lower labials	Pre-ocular
30684	♀	153	38	20–17–15	7–7	9–9	3–3
30685	♀	147	36	19–17–15	7–7	9–9	3–3
30686	♂	154	46	19–17–15	7–7	8–8	3–3
30687	♂	154	44	19–17–14	7–7	9–8	3–3
30688	yg.	153	37	19–17–15	7–7	9–9	3–3
30689	♀	150	39	19–17–15	7–7	9–9	3–3
30690	♀	153	38	19–17–15	7–7	9–9	3–3
30691	♀	152	38	19–17–15	7–7	9–9	3–3
30692	♀	156	38	19–17–15	...	...	3–3
30693	♂	149	41	19–17–15	7–7	9–9	3–3
30694	♂	153	45	19–17–15	...	...	3–3
30695	♀	153	38	17–17–15	7–7	9–9	3–3
30750	♀	150	37	17–17–15	7–7	9–9	3–3
30751	♂	152	45	19–17–15	7–7	8–8	3–3
30752	yg.	153	37	19–17–15	8–8	9–9	3–3
30753	♀	146	38	19–17–15	7–7	9–9	3–3
30754	♀	153	37	19–17–15	7–7	7–9	3–3
30755	♂	154	45	19–17–15	7–7	9–9	3–3

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